FARM GRASSES *of the* UNITED STATES

WILLIAM JASPER SPILLMAN

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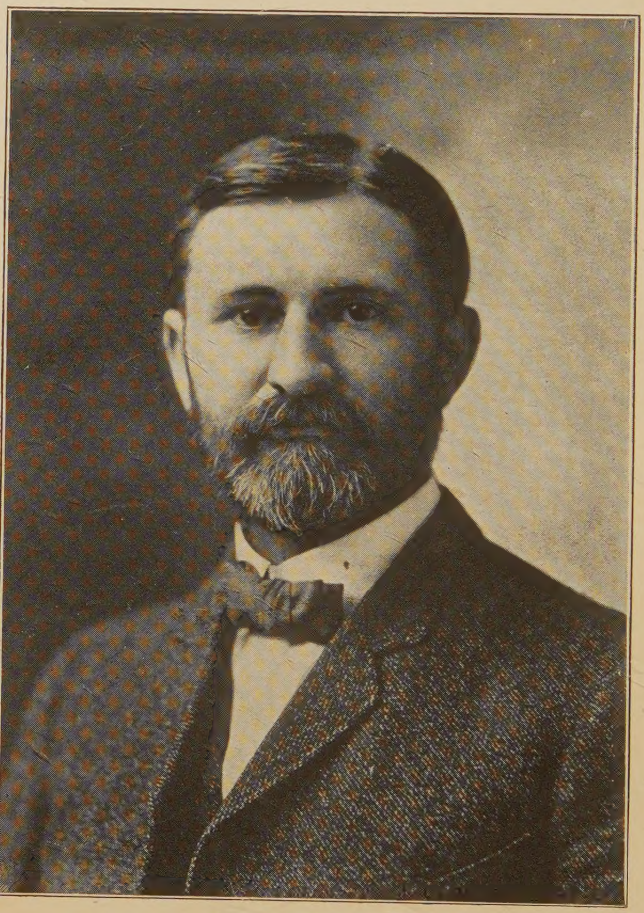

W. J. Spellman

Farm Grasses
of the UNITED STATES

A PRACTICAL TREATISE ON THE GRASS CROP, SEEDING AND MANAGEMENT OF MEADOWS AND PASTURES, DESCRIPTIONS OF THE BEST VARIETIES, THE SEED AND ITS IMPURITIES, GRASSES FOR SPECIAL CONDITIONS, ETC., ETC. .· .· .· .· .·

By

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ILLUSTRATED

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PREFACE

IN preparing this volume the object has been to present, in connected form, the main facts concerning the grasses grown on American farms—in so far, at least, as these facts are of interest to the farmer. Actual practice in grass growing has been set forth wherever information concerning it has been available. The writer has attempted to view every phase of the subject from the farmer's standpoint—with what measure of success the reader must judge for himself.

The country may be divided into four regions, each of which presents a different set of problems. In the region of timothy, clover, and blue-grass, grass problems are comparatively unimportant; they relate mainly to methods of growing and utilizing well-known grasses, and to methods of improving these grasses by separating them into their constituent varieties and selecting out the best. This region covers the Northeastern quarter of the country, and certain localities in the West and the Middle South. In the South, while excellent grasses are not wanting, it happens that most of the grasses best adapted to the region possess characteristics which render their management on the farm a matter of much difficulty. This subject is discussed at length in the chapter on Bermuda and Johnson grasses. Grasses having fewer objectionable features

are much sought after by Southern farmers, and some suggestions are made in the text concerning hay and pasture plants worthy of trial. Methods of fitting grass crops into Southern cropping systems constitute another important problem which the farmer must work out largely for himself. The best we can do for him in this line is to give him the benefit of the experience of the most progressive of his fellows. This the writer has attempted to do.

On the irrigated lands of the West, farmers are not particularly concerned about grass problems, except where alkali has begun to appear. But there are immense areas in the West at present unutilized, except in the primitive fashion of the herdsman on the open range, on which the problem is to find grasses that will produce a crop under arid or semi-arid conditions. In so far as the solution of this difficulty has been accomplished, the results are set forth in discussing the individual grasses. Attention is called to investigations now in progress with a view to finding other grasses adapted to these hard conditions.

The chapter on seeds was contributed by Mr. Edgar Brown, in charge of the Seed Laboratory of the United States Department of Agriculture.

The chapter on "Lawns and Lawn-making" was prepared by Mr. C. R. Ball, of the United States Department of Agriculture.

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Fig. 13—Pieters & Brown, Bulletin 19, Bureau of Plant Industry, U. S. D. A.

Fig. 14—Pieters & Brown, Bulletin 19, Bureau of Plant Industry, U. S. D. A.

Fig. 15—Pieters, Farmers' Bulletin 123, U. S. D. A.
Fig. 21—Scribner, Agros. Bulletin 21, U. S. D. A.
Fig. 23—Scribner, Agros. Bulletin 14, U. S. D. A.
Fig. 24—Scribner, Agros. Bulletin 7, U. S. D. A.
Fig. 27—Tracy, Agros. Bulletin 15, U. S. D. A.
Fig. 29—Scribner, Agros. Bulletin 17, U. S. D. A.
Fig. 31—Scribner. Agros. Bulletin 7, U. S. D. A.
Fig. 32—Scribner, Year-book 1897, U. S. D. A.
Fig. 34—Scribner, Agros. Bulletin 7, U. S. D. A.
Fig. 36—Scribner, Agros. Bulletin 7, U. S. D. A.
Fig. 37—Scribner, Agros. Bulletin 7, U. S. D. A.
Fig. 38—Scribner, Agros. Bulletin 17, U. S. D. A.

W. J. Spillman

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U. S. Department of Agriculture, 1905.

FARM GRASSES
OF THE UNITED STATES

I

THE GRASS CROP

THE word "grass" is used in two senses. Popularly it is applied to those plants that furnish hay and pasture. In this sense it includes the clovers, alfalfa, the vetches, spurry, and other plants belonging to various families. Botanically the term is applied only to representatives of a single family, known to botanists as the *Gramineæ*, or true grasses. In this volume, in order to avoid burdensome phraseology, the word is sometimes used in the one sense and sometimes in the other, but the context will always indicate the meaning intended. In the present chapter the term is made to include those plants which are generally grown for hay and pasture purposes.

According to the Census of 1900, about 18 per cent. of the total area of the United States is classed as improved land. This does not take into account Alaska or our insular possessions. This 18 per cent. amounts to 414,000,000 acres. Of this, only 289,000,000 is devoted to harvested crops, including some 15,000,000 acres of wild grasses cut for hay. This leaves about

125,000,000 acres of improved land devoted to orchards, woodlands, and pastures. Since practically all the improved woodland is pastured, and since the area in orchards is relatively very small, it is safe to say that at least 120,000,000 acres of this area is grass-land used for pasture purposes. Of the harvested crops, about 59,000,000 acres is devoted to hay. It is thus seen that the hay crop occupies over 22 per cent. of all land from which crops are harvested, while hay and pasture lands together constitute about 43 per cent. of the total area of improved land. The value of the hay crop for the year 1899 is estimated at $484,256,846. The only crop exceeding this was corn.

It is impossible to estimate the value of the feed obtained from the 120,000,000 acres of improved pasture-land; but when we add the value of this and the pasture value of the remaining 82 per cent. of the total area of the country classed as unimproved land, nearly all of which is grazed, it is probable that the grass crop surpasses in value any other crop. But since hay is too bulky and usually too cheap to bear long-distance shipment, comparatively a small proportion of it finds its way to the markets. It is fortunate that at least one important crop must, from its very nature, be largely consumed on the land where it is produced. Otherwise we should long ago have reduced the fertility of practically all the farm lands in this country to so low a point as to have rendered farming unprofitable, just as has been done in all the older parts of the country where livestock farming has been neglected. It is a notable fact that in those portions of the country which have enjoyed the most per-

manent prosperity, the grasses and livestock have always occupied an important place. In the New England States, which have felt keenly the competition of the fertile lands of the Central West, agriculture has been able to maintain itself only by devoting the major portion of the improved land to grasses. Other crops may form the basis of temporary prosperity, as has

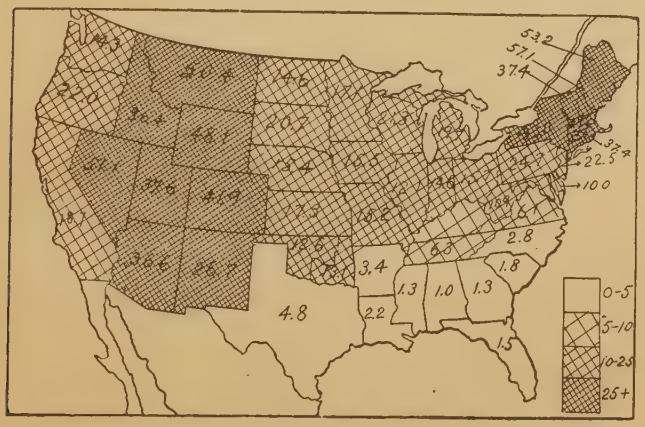

FIG. 1—PERCENTAGE OF IMPROVED LAND DEVOTED TO HAY AND FORAGE

been the case with wheat on the prairies of the Northwest and the Pacific Northwest, and cotton in the South; but it was a prosperity that rested on too slender a basis, and, in both cases, led to disaster.

The distribution of the grass crop in the United States is shown in Fig. 1. This shows the percentage of improved land in each State devoted to hay and forage. The States may be divided into four fairly distinct groups, based on these percentages. The first

group consists of the cotton-producing States, in which the area of grass lands is less than 5 per cent. of the whole. This group of States was so unfortunate in their early history as to find their lands and climate adapted to a crop that was highly profitable, but which returned nothing to the soil. Livestock farming and grass culture were almost wholly neglected. As the lands wore out, resort was had to commercial fertilizers; but these did not add humus to the soil, and the mechanical condition of the soil has reached that stage where rain washes it so badly that it is necessary to terrace in order to keep the soil from washing away. The results achieved by many progressive farmers in the South show conclusively that a proper use of grasses and stable manure render terracing unnecessary except on decidedly rolling lands, and make the soil highly productive. Diversified farming is rapidly coming into favor in the South, and the area devoted to hay and pasture crops is increasing. This undoubtedly means a return to permanent prosperity.

Hay production, generally speaking, is not an important industry in the South. It has become important in a few localities. In the Red River Valley in Louisiana and Arkansas a considerable area of alfalfa is grown, and the area devoted to this valuable crop is rapidly extending. On a narrow strip of prairie soil extending from northeastern Mississippi through central Alabama and terminating near Macon, Georgia, Johnson grass has long been grown in considerable areas. The same grass is grown more or less extensively on similar soil over much of central Texas. Alfalfa thrives abundantly on these black soils, and is

coming into general use as a hay crop in recent years. In the vicinity of Augusta, Georgia, on both sides of the Savannah River, considerable hay is grown for the local markets. The same is true in restricted localities in northern Florida. In general, however, the prevailing system of farming consists of growing cotton and corn. This system has thoroughly worn out the soil except in the richer alluvial sections, so that good crops are seldom produced, even with the stimulus of commercial fertilizers, which are universally applied—at least, to cotton—in all the older settled sections.

Regarding the profit from hay farming in the South, Mr. F. A. Quinett, who operates two large hay farms near New Orleans, says, in a letter to the Department of Agriculture: "Formerly we found it difficult to sell our hay. We now have the best patronage, and are unable to meet the demand. One hundred acres last year gave about four hundred tons of hay, which we sold at $10 to $14 per ton. We consider the hay business decidedly more profitable than any other style of farming."

The next group consists of the States of Tennessee, Kentucky, and Virginia. In these, the grasses are largely confined to certain localities; in Virginia, to the valleys between the mountain ranges in the western part; in Tennessee, to the mountain valleys of the east, and to the limestone soils of the central part of the State; in Kentucky, largely to the northern border and the north central part. In these three States the percentage of grass-lands ranges from 5 to 6.3.

The third group consists of those States in which agriculture is most widely diversified, and the agricul-

tural wealth of the country is mostly concentrated. In them, from 10 to 25 per cent. of the improved land is devoted to hay and forage crops. The last group consists of the Rocky Mountain States and New York and New England. In these States the grass area exceeds 25 per cent. of the total. The large amount of hay grown in these two groups of States is due to special conditions. In the Mountain States the chief industry is stock-raising on the ranges, and the hay is grown for winter feed. The proportion of grass to other crops is indeed larger here than is called for in properly diversified agriculture, and there is much talk of the need of grains for finishing off cattle. In New York and New England much hay is grown for market. Dairying is also an important industry. Unlike Iowa, Wisconsin, and other great dairy States in the Central West, where concentrated dairy feeds are largely produced on the farm, New England finds it more advantageous to devote her lands to grass, and to buy grain and mill products for her cattle.

The data concerning the hay and forage crops of the country are given in Vol. VI., Census of 1900, under the following headings: "Wild, Salt, and Prairie Grasses," "Millet and Hungarian Grasses," "Alfalfa or Lucern," "Clover," "Other Tame Grasses," "Grains Cut Green for Hay," and "Forage Crops." The distribution of each of these crops will be discussed later. The data for clover relate to clover sown alone, and include all the varieties. When sown with timothy or other true grasses, clover is included under "other tame grasses." Grains cut green for hay here includes peas as well, since, in the North, peas are

usually sown with oats when grown for hay. It also includes the cow-peas of the South when cut for hay, though these are practically never sown with grain. Under "Forage Crops" are included sorghum, Kafir-corn, milo maize, Indian corn, etc., when cut and fed in the green state, made into silage, or when grown for the fodder alone, as all of these crops except Indian corn and Kafir-corn usually are. The two latter, when grown for grain, are not included here.

The crop designated "other tame grasses" is by far the most important of all. It includes timothy, timothy and clover, redtop, orchard-grass, brome-grass, meadow-fescue, tall meadow oat-grass, etc. There are no definite data to indicate in what proportion these grasses occur, but common observation and extensive correspondence with farmers indicate that the area of all others together is decidedly small when compared with the area of timothy, or a mixture of timothy and clover, and we may fairly refer to the region producing this crop as the "timothy region." Omitting for the present the wild grasses, these hay crops will be considered in the order of their importance.

By reference to the map (Fig. 17), it will be seen that the crop designated as "other tame grasses" occurs principally north of the Ohio River and east of the west line of Missouri and Iowa. The area of this crop is given as 31,302,000 acres. It therefore constitutes 74 per cent. of the total area of tame hay. The average yield is 1.1 tons per acre, making a total of 35,624,000 tons of hay, consisting almost exclusively of timothy, or timothy and clover. The yield per acre of this crop is lower than that of any other tame hay

crop. This is largely due to the prevailing habit of leaving timothy meadows down after they have become unproductive.

It is a remarkable fact that nearly all the grass literature issued by the American experiment stations comes from those stations outside of the timothy region. Inside this region the early introduction of timothy, red clover, and Kentucky blue-grass solved the grass problem in a manner satisfactory to the farmer before the establishment of the experiment stations, and these institutions have, therefore, devoted their energies to more pressing problems. The most important grass literature from these States is to be found in the reports from early agricultural societies. These reports indicate that grass problems were at one time as important in the region in question as they now are outside of it. Nearly all the correspondence that comes to the office of Grass and Forage Plant Investigations of the United States Department of Agriculture originates either in the cotton-growing States, where grass culture has been neglected, or in the arid and semi-arid West, where satisfactory grasses are yet to be found.

Clover ranks next to "other tame grasses" in the area devoted to it. The figures apply, of course, to the clovers when sown without timothy or other true grasses. The area devoted to clover is 4,104,000 acres, or 7 per cent. of the total area of tame hay The average yield of this class of crops is given at 1.3 tons per acre. The clovers, particularly the common red clover (*Trifolium pratense*), are much more important in American agriculture than these figures

would indicate. In the first place, red clover is very commonly sown with timothy, the area thus sown probably being several times as large as the area of clover sown alone. In the second place, they are nitrogen gatherers, and are thus of vast importance in furnishing nitrogenous material in feed-stuffs and as soil renovators. But a further discussion of this subject would transcend the limits of this volume, which is confined, except in a most general way, to a discussion of the true grasses.

The next most important crop in the list consists of grains cut green for hay. Its distribution is shown in Fig. 2. The area of this crop is 3,884,000 acres, and the average yield 1.3 tons. The grains are used extensively for hay only on the Pacific Coast. On non-irrigated lands in Idaho, Washington, Oregon, and California, where the rainfall is sufficient to permit of farming, wheat is by far the most important crop. Over much of this area wild oats are very troublesome, and the principal hay consists of patches of wild oats cut in wheat-fields. Even where wild oats are not troublesome, as where the rainfall is less than about eighteen inches annually, much wheat is cut for hay. If cut at the proper stage, wheat, and the other cereals as well, make excellent hay for all kinds of stock. In California beardless barley is used extensively for hay; this crop is also coming into use in Oregon and Washington for the same purpose. Alfalfa and brome-grass (*Bromus inermis*) are also rapidly coming into favor on the wheat-lands east of the Cascade Mountains in the two States last named.

Throughout the Central and Southern States the

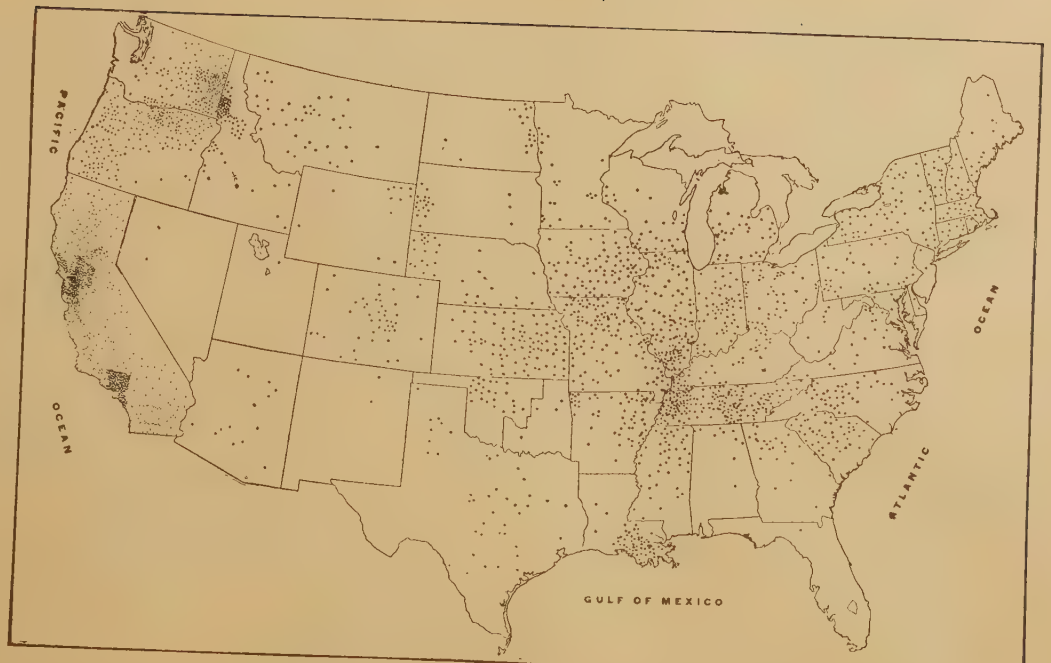

FIG. 2—GRAIN (INCLUDING COW-PEAS) CUT GREEN FOR HAY
Census 1900. Unit, 1000 A

grain hay consists mostly of oats cut and fed in the sheaf, and of cow-peas. The thick patch of grain hay shown in southern Louisiana consists entirely of cow-peas grown on sugar plantations, both for hay and for their fertilizing effect on the soil. At the North, Canadian field peas are sometimes sown with oats for hay, but the area is quite limited. They hardly extend as far south as central Pennsylvania and central Ohio.

The hay crop next in importance is alfalfa, of which 2,094,000 acres is reported in the Census of 1900. This is confined almost entirely to the West, and largely to irrigated land in that section. Alfalfa, as an important crop, stops at the western limit of "other tame grasses," as shown in Fig. 17. It is now rapidly gaining ground in the East and South. The average yield per acre is 2.5 tons—nearly double that of any of the preceding crops.

Last in the list of tame hay crops are "Millet and Hungarian grasses." Of these, 1,744,000 acres are shown in the census returns, with an average yield of 1.6 tons per acre. Their distribution is shown in Fig. 20, and the millet crop is discussed in detail in Chapter VIII.

The acreage of forage crops is placed at 3,107,000. The average yield of dry forage is 2.6 tons per acre. Kansas leads in the production of forage. Sorghum and Kafir-corn are eminently adapted to the western margin of the humid region; sorghum does equally well in the whole of the cotton-producing section, where it is highly important as a fodder crop. It is also much used in the South as a green feed for summer and as pasture for all kinds of stock.

The wild hay crop is much more important than is generally believed. No less than 15,417,000 acres of wild grasses were cut for hay during the census year, though the area is rapidly diminishing. The average yield is 1.1 tons per acre, or the same as that given for "other tame grasses." The distribution of the wild hay crop is shown in Fig. 3. The chief acreage is shown to be in the States bordering the western edge of the timothy region. In Iowa, Wisconsin, and part of Minnesota, wild hay is cut chiefly on wet lands; farther west, mostly on upland prairies; still farther west, in swales and draws in the arid region. The principal grasses constituting this wild hay, and the possibility of domesticating some of them, are mentioned later in this volume.

RECAPITULATION

The following table presents the statistics for hay and forage crops in more compact form. The figures are from the Census of 1900:

ACREAGE OF HAY AND FORAGE

	Acres	*Average yield in tons per acre*
Wild, salt, and prarie grasses	15,457,000	1.1
Millet and Hungarian grasses	1,744,000	1.6
Alfalfa, or lucern	2,094,000	2.5
Clover	4,104,000	1.3
Other tame and cultivated grasses	31,302,000	1.1
Grains cut green for hay	3,884,000	1.3
Total	58,585,000	1.2
Forage crops	3,107,000	2.6
Grand total	61,692,000	1.3

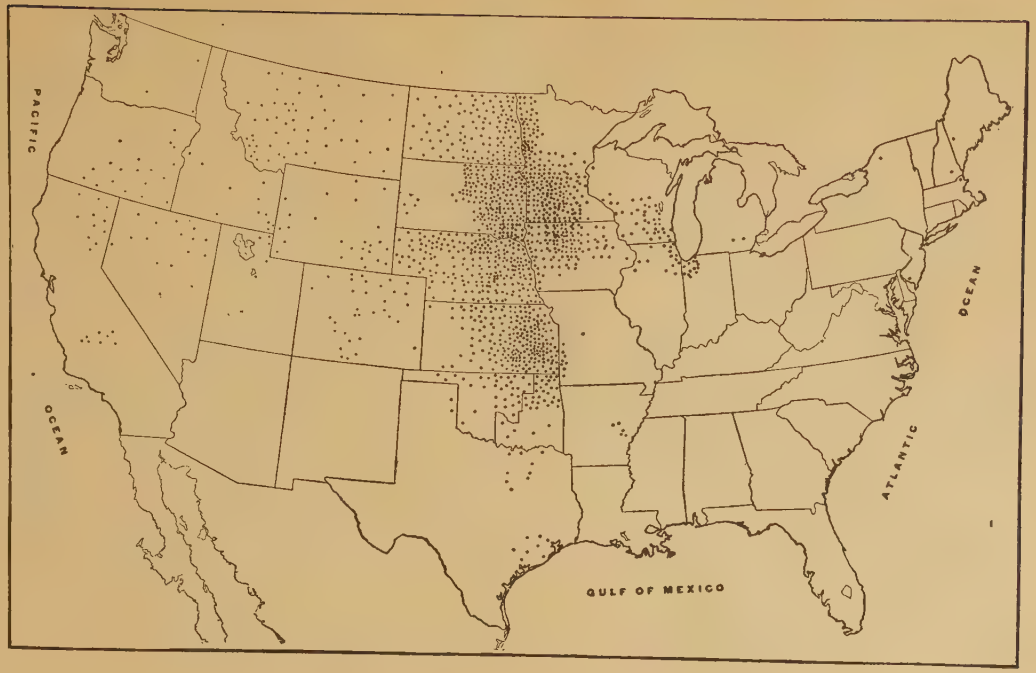

FIG. 3—WILD, SALT, AND MARSH GRASSES CUT FOR HAY

II

MEADOWS AND PASTURES

EXCEPT in comparatively few localities, the American farmer has never learned the art of maintaining grass-lands in a permanently productive condition. This is partly due to the character of the grasses grown, and partly to the treatment accorded grass-lands in this country. There are only three important hay and pasture plants commonly grown in America that naturally tend to increase in productiveness after the second year. These are alfalfa, Bermuda grass, and blue-grass (*Poa pratensis*). When any one of these is once established on land to which it is thoroughly adapted, it remains productive for many years, if given proper treatment. But such grasses as timothy, redtop, brome-grass, Johnson grass, orchard-grass, and tall oat-grass all decrease markedly in yield after the first crop year—at least, with the treatment they ordinarily receive. Whether a meadow consisting of these grasses could be maintained productive indefinitely is doubtful.

In the real grass-growing section of the country, which lies north of the Ohio and Potomac rivers and east of Nebraska and Kansas, including portions of Virginia, Kentucky, Kansas, and Nebraska, meadows ordinarily consist of timothy and red clover. The latter plant has come to be regarded as practically a bien-

nial. In reality it is a perennial, capable of remaining productive for many years, but it is subject to so many insect enemies and fungous diseases that it usually ceases to be productive in one or two years. On the Pacific Coast, where these enemies have not yet become established, productive fields of clover ten or fifteen years old are not uncommon. As stated above, timothy becomes much less productive after the first crop-year. The American farmer has, therefore, come to regard a meadow as a temporary thing, and there has not been much attempt to maintain such permanent grass-lands as are found in England and the Continent of Europe.

Among our farmers the usual method of procedure is to sow timothy in the fall with wheat, adding clover in February or March. On account of the presence of the wheat, no grass crop is produced the first year. The next year two crops of hay are cut, the first consisting of mixed clover and timothy, the second almost entirely of clover. A few of our best farmers get three crops, though many others get only one. The next year one or two smaller crops are cut. When timothy is sown alone, as it frequently is, there is only one cutting a year. After the second crop-year any one of three courses is followed. A good many farmers spread the available supply of barn-yard manure on the meadow during the winter after the second crop-year, and in the spring plow up the sod for corn. Some continue to cut it for hay till weeds compel them to plow it up. Others use it for pasture one, two, or three years before plowing it up for corn. Sometimes blue-grass is sown with the clover when the meadow is

laid down, and the field converted into more or less permanent pasture after one or two years' use as meadow.

On account of the usual low yield of old meadows and most old pastures, progressive farmers maintain that they cannot afford to keep lands permanently in grass. This is particularly the case in sections of the country where dairying is the leading feature of farming, especially where land is high-priced. In fact, there is a tendency in some sections to dispense with pastures altogether on dairy farms, except for the young stock, and to substitute the system of green feeding (soiling) instead, because of the greater amount of feed that may be obtained from the same area by this system as compared with pasturing. Whether better results could be obtained from permanent or semi-permanent grass-lands by using such mixtures as are used in Europe, instead of depending on timothy and clover, as our farmers do, is doubtful, for the most highly prized European grasses do not thrive well in the Eastern section of the United States. The most important grasses of Europe are English and Italian rye-grasses, meadow-fescue, timothy, orchard-grass, and meadow-foxtail. Of these, timothy is the only one that can be said to be important in the real grass-growing section of this country. The rye-grasses and meadow-foxtail are entire failures (in our timothy region), and orchard-grass and meadow-fescue (here called English blue-grass) are important only in very restricted areas.

Much has been written concerning the care of meadows in this country, a good deal of it copied from

European authorities. With our conditions, about the best treatment seems to be to plow up the meadow for corn at the end of the second year. Where the pasture is needed, as it certainly is on beef-producing farms, the old meadows may well be used for pasture a year or two before plowing up for corn. Where the manure is available, it is good practice to top-dress the meadow each winter after the last crop of hay is removed in the fall.

Instead of sowing the timothy in the fall with wheat, and adding the clover in spring, it is much better, in most parts of the Timothy Region, to sow the timothy and clover together late in August or early in September, on well-prepared and well-manured land, without a so-called nurse crop of wheat or other grain. This will give a heavy yield of hay the next summer. After this hay crop is removed, top-dress well the next winter, and cut for hay again the next summer. After this, top-dress in winter and plow in spring for corn. This applies to good arable land in those parts of the country where timothy and clover thrive, and where corn is a paying crop. Such a plan, of course, presupposes an abundance of manure. It is recognized that there is much land well adapted to meadow purposes, but not adapted to other ordinary crops. In certain sections also blue-grass is so highly productive that it pays to sow blue-grass with the timothy and clover, and make a pasture of the meadow after the second-crop year. (See chapters on timothy and blue-grass.) There is also a great deal of land unfit for cultivation which, with proper attention, may be rendered fairly productive as pasture. It is therefore important to

consider the best methods of handling such lands in order to keep the grass in the most productive condition. The methods to be employed in any particular locality depend, of course, on the nature of the grasses best adapted to that locality. Much that might be said here is therefore deferred to later chapters, in which the grasses are discussed individually, and in which the treatment to be accorded each particular species is set forth in detail.

PREPARATION OF THE SEED-BED

When timothy is sown in the fall with wheat, and clover added in the spring, as is usually done in the timothy region proper, little need be said regarding the preparation of the seed-bed. Wheat, in the region in question, usually follows either oats or corn. When it follows oats it is well to plow under a light dressing of barn-yard manure in preparing for the wheat and grass crop. It is important that the land be plowed when it is in "good season," as Southern farmers say; that is, when it has just moisture enough in it to pulverize nicely. In fact, the breaking of land should always be done when it is in this condition, but this is, of course, not always possible. The harrow should be used freely, so that a fine tilth may be secured before the seeding is done. The manure gives the timothy and clover a good start, and the fine tilth renders a catch of timothy much more certain.

When wheat and timothy follow corn, it is usually sufficient to disk the corn-stubble a couple of times after the corn is in the shock, unless the land is foul. It is to be presumed that the corn-land had a good

dressing of manure the previous winter or spring, in which case it is hardly necessary to manure again at this stage. Where there is a deficiency of manure, as in some parts of the East, a dressing of phosphate is usually applied to the land and harrowed in just before the wheat is sown, or even with the wheat.

As elsewhere stated, it is better practice to sow timothy and clover alone in the late summer or early fall. Oat-stubble is well suited for this purpose, especially in the northern tier of States. In the region of the Ohio River it is possible to grow a catch crop in summer, such as millet or cow-peas, before seeding to grass in the fall. In either case it is a good plan to manure the land, the quantity required depending on the fertility of the soil before breaking up for grass. Plowing done at this season should be fairly deep—say, seven to nine inches. It is highly important to secure a good tilth before sowing the grass-seed. If the soil is inclined to be stiff, as most clay soils are, the disk-harrow is a very useful implement in putting it in shape for sowing. On loose soils the common drag-harrow is sufficient. In the Middle South, where orchard-grass, redtop, tall meadow oat-grass, and meadow-fescue partially replace timothy, more care is required in preparing grass-lands than in most other parts of the country. Here much of the soil has been exhausted by the continuous cultivation of cotton and corn, and barn-yard manure is frequently not available. The practice of subsoiling has become very general in this section.

The usual manner of subsoiling is to run a "scooter" in the furrow behind the turning-plow.

The scooter-plow is unknown at the North. It is a kind of shovel-plow having an oblique point. It digs up the clay, but leaves it in the furrow. A great deal of time and labor is wasted in this manner in northern Georgia, northern Alabama, and adjacent sections. It is argued that if this subsoil were turned up and mixed with the soil it would greatly reduce the yield, which is very true. The idea is to break up the hard-pan which has been formed just below the furrow slice. But this can be done in a far better way. By plowing one inch deeper every year till a depth of ten inches is reached, a ten-inch layer of good surface soil is secured without at any time having a lot of unproductive hard-pan mixed with the soil. After this depth has been reached it is a good plan never to plow the same depth two years in succession. Plow, say, seven inches the next year, then nine inches the next, then six, then ten, then eight, and so on. If this practice is followed there will be no hard-pan to break up. There are many farms on which all the plowing must be done by one small mule. Ten-inch plowing is, of course, out of the question in such cases.

The preparation of good alluvial soil for grass in the Middle South does not differ materially from the methods required in the North, but the uplands require considerably more care. It is useless to attempt to grow meadow-grasses on exhausted upland soils in the Middle South. The soil must first be brought into good heart. This may be done by sowing Southern grown winter rye and turning it under about the time it heads out, and by growing and turning under cow-peas or velvet beans. It is very important, when any heavy

green crop has been turned under, to allow it to decay, and let one or two good, soaking rains wash the resulting acids out of the soil before sowing any other crop. A very good preparation for worn upland soils would be to turn under a crop of rye, let the land lie six weeks, then sow cow-peas. Cut the peas for hay in time to sow rye again in the fall. Turn rye under again the next spring, and grow another crop of peas. By the time this second crop of peas is cut for hay the land ought to be in fairly good condition to receive a grass crop.

For the particular condition here described the best grasses are orchard-grass, redtop, tall meadow oat-grass, and meadow-fescue, with red and alsike clover. On most of these soils, except where rock is near the surface, alfalfa can be started readily after the above course of treatment. A very good combination would be: orchard-grass, 10 lbs.; redtop, 5 lbs. of recleaned seed, or 12 lbs. of seed in the chaff; tall meadow oat-grass, 12 lbs.; red clover, 8 lbs.; and alsike clover, 4 lbs. In the absence of barn-yard manure, a dressing of 200 to 400 lbs. of a high-grade, complete fertilizer would give the grass a good start. After this grass has been down two years, during which time it ought to give two cuttings a year, it should be manured and plowed up for corn. The corn may be followed by rye or wheat the next winter. Cow-peas may advantageously follow the grain crop, and give way to the grass crop again in the fall. This makes a four-year rotation, which keeps the land busy winter and summer. If all these crops are fed on the place and the manure returned to the land, this system of cropping cannot fail

to bring the soil to a high state of fertility in a few years.

We may summarize the subject of preparation of land for grass by saying that it must first be made fairly fertile if it is not already so, and that it must be plowed deep when in condition to pulverize well, and then be thoroughly fined by the harrow. It is then ready for the seed.

SOWING THE SEED

The importance of good seed can hardly be overestimated. In the chapter on seeds the prevalence of poor grass-seed on the markets and some of the reasons for the same are pointed out. A good many failures in seeding down the grasses result from insufficient preparation of the land, but many failures result also from the use of seed which for one reason or another has lost much, or all, of its vitality. This is about the only civilized country in the world in which there are no laws to protect the farmer against imposition on the part of dishonest seedsmen, and honest seedsmen find much difficulty in selling high-class seed alongside of dead seed, which is offered at a low price. A farmer ought always to buy grass-seed far enough in advance to enable him to send a sample of it to the seed laboratory of his State experiment station, if the station maintains one, or to that of the United States Department of Agriculture, which is always ready to test such seeds free of charge. If this practice were general, bad seed would be less plentiful on the market, and there would be fewer failures when grasses are sown. The danger from bad seed is much

greater in the case of such grasses as tall meadow oat-grass, meadow-fescue, Italian rye-grass, and the like, which are so little used in this country. The stock is liable to be old, and such seeds should always be tested before risking good land to them. The same is true of blue-grass, Johnson, and Bermuda grasses, which are especially liable to be of poor quality.

The rate at which the various grass-seeds are to be sown is given in discussing the individual grasses later in this volume. When mixtures are sown, a number of considerations govern the amount of each kind of seed to use. In sowing grasses and clovers together it is customary to sow enough of both grass-seed and clover-seed for a full stand. But if several grasses are used in the mixture, the amount of each is usually somewhat reduced. In parts of the Timothy Region it is customary to add more or less redtop to the timothy and clover (except when the hay is grown for sale), but the amount of timothy-seed is not thereby reduced. The amount of each kind of seed to be used depends partly on how much of each kind of grass is desired in the hay. Redtop is usually added as a "filler," to increase the yield, rather than because of its desirability in the hay, and hence the proportion of its seed is usually small. In the mixture above recommended for uplands in the Middle South, the amount of orchard-grass is about half what would be sown if this were the only grass to be sown with the clovers. The amount of redtop is about one-fourth, and that of tall meadow oat-grass about one-third of a full seeding.

Some authorities recommend that nearly as much of each kind of seed be used in a mixture as if it were

to be sown alone, and this is a very good rule if one is not sure of the quality of the seed. A general rule, but one that should seldom be applied strictly, is to reduce the amount of each kind of seed in proportion to the number of kinds in the mixture. This rule should be used with much caution, yet it is a guide of some value. If more or less of a given grass is wanted in the mixture, use its seed accordingly, and always make sure of sufficient seed of the best grasses in the mixture to secure a stand if the less important kinds should fail entirely. An indefinite number of mixtures could be given as samples, but it would occupy more space than can be devoted to it in this volume to give the total number of such that might be used under varying conditions in the various parts of the country. Seedsmen usually make recommendations on this point in their catalogues, but such recommendations cannot be followed implicitly.

Other things being equal, rich land requires more seed than poor land, and wet land more than dry. A well-prepared seed-bed requires less seed than one poorly prepared, because a larger proportion of the seed finds a chance to germinate. A single pound of timothy-seed to the acre, if every seed produced a thrifty plant, would give 27 plants on every square foot of land. Since it usually requires 12 to 15 lbs. of timothy to secure a good stand it is evident that only a small proportion of the seed sown on even the best-prepared land produce plants. On rough, cloddy land the proportion is much smaller. Seedsmen, in their recommendations as to the amounts to sow, make a good deal of allowance for poorly prepared land, and

it is well they do, or there would be more failures than there are.

From the above it is evident that no absolute rules can be laid down for determining the amount of seed to sow on an acre of land. One must consider all the circumstances and be governed accordingly. A beginner will do well to consult the experience of those who have farmed in his locality for many years. In case such experience is not available, use a liberal allowance of seed until experience has taught the proper rate of seeding. As much definite information, based on farm experience, is given in later chapters as can be given on this point.

III

MEADOWS AND PASTURES (*Continued*)

TIME TO SOW

A GOOD seed-bed is more important than the particular date of sowing. It is unwise to sow grass-seed on soil that is too dry to give the grass a quick start. Ground that is at all weedy should never be sown in late spring, or weeds will choke out the grass. Over most parts of the Eastern United States grass-seed may be sown either in early fall or in very early spring. Fall sowing should be early enough to give the grass a good start before winter. In sections subject to late summer drouth it should be so timed as to escape the dry, hot weather. Spring sowing should be early enough to give the grass a start ahead of weeds. In middle latitudes most grasses and clovers may be safely sown on a light snow in late winter. When the snow melts the seed will be sufficiently covered by the shifting of soil due to the water formed from the melting snow. Perhaps the safest general rule, to be used with judgment, is to sow in early fall if the season is favorable. If not, then sow in early spring. Some kinds of seeds produce plants that are especially tender when young. This is more generally true of alfalfa and clover than of the grasses. North of the Ohio River it is safer to sow these in spring, while farther south

they are best sown in early fall. Yet in the North all these plants may be successfully sown in late summer if the soil is in good condition. Late fall sowing is seldom advisable, for it is unsafe to let a meadow of any except the hardiest grasses go into winter without a good covering on it. In the colder regions of the Prairie States it is well to plow the land in fall, then prepare it, and sow the seed in early spring. In the Pacific Northwest, on upland prairies east of the Cascade Mountains, it is best to plow in spring and sow the seed at once. The reasons for this are given in the chapter on timothy. In the irrigated districts of this section fall sowing is advisable, while west of the Cascades the same rules apply as in Ohio, Pennsylvania, and adjacent States. At high altitudes in the Rockies spring sowing is safest because of the cold winters.

MANNER OF SOWING

Very light, chaffy seeds, such as those of bromegrass, especially the imported seed, and awned seeds, such as those of tall meadow oat-grass, do not feed through seeding-machines satisfactorily, and should, therefore, be sown by hand. Hand-sowing should always be done when the air is as still as possible. It is well-nigh impossible to distribute the seed evenly when the wind is blowing. Unless the sower is decidedly expert, it is best to sow half of the seed at a time, making the second sowing crosswise to the first. This insures a more even stand.

For such seeds as will feed through it, such as timothy, redtop (recleaned), clovers, etc., in general, for small, round, clean seeds, the wheelbarrow-seeder is

the most satisfactory implement yet invented. Recleaned blue-grass seed can be sown with this implement, but the uncleaned seed should be sown by hand. Grass-seeders are frequently attached to grain-drills. They answer very well for timothy to be sown with grain, but are hard to keep in order. There are several cheap grass-seeding machines which scatter the seed by mechanical means. They are satisfactory for seeds that feed through them readily, but it requires some patience to regulate them properly, and the sower must walk at a uniform rate or the seed will not be scattered evenly.

Seeds of approximately the same size and weight may be mixed before sowing. Very large seeds should never be mixed with small ones, or the small seed will feed out first. If heavy seeds are mixed with light ones, even of the same size, the heavy ones will feed out first unless the mixture is kept well stirred. In sowing such mixtures it is well to put only a small amount of seed in the machine at a time. By this means the separation of the heavy and light seeds is largely avoided.

NURSE CROP

Just why wheat or other grain sown with the grasses should be called a nurse crop is not clear. It would be more appropriate to call it a robber crop. The idea that it protects the grass probably arose from the fact that, when the grain is removed in hot, dry weather, the grasses are apt to dry up. Having been shaded and weakened by the grain, they are unable to bear the full heat of the sun, particularly when the supply of moisture is short and the grain crop has

robbed them of their scant supply. In no part of the country is it a safe plan to use a so-called nurse crop for the grasses, except, perhaps, in parts of the North, where weeds are liable to take spring seeding. In this case a light seeding of oats or barley will tend to keep down the weeds, and will not seriously harm the grass if the grain is cut for hay while yet green. If left to ripen it is liable to do the grass harm. In the South a nurse crop should never be used.

The idea is prevalent that a crop can be gained by sowing grain with the grasses. This may be true of spring seeding, but it is not true of fall seeding. Fall-sown grasses without a nurse crop make their largest yield the next summer; with a nurse crop, they usually make no hay till the second summer.

COVERING THE SEED

Seeds sown on other crops in late winter or early spring usually need no covering. At other times a light drag-harrow or a brush does the work well. Soils that are loose or inclined to be cloddy should be rolled after seeding, but the harrow should follow immediately after the roller. On clay soils particularly the roller has a tendency to cause the surface to bake and form a hard crust, through which the young plants cannot penetrate. A good rain just after seeding frequently covers the seed sufficiently. It is important not to disturb the soil while the seeds are germinating, as the little plants are very easily destroyed at this time. No attempt should therefore be made to remedy insufficient covering after the seed have begun to germinate.

Large seeds, such as those of brome-grass, Johnson grass, etc., may be covered more deeply than such small seeds as blue-grass, timothy, and the clovers. These larger seeds may safely be put down with a drill. In light soils seeds as small as clover may be sown with a drill. On ordinary soils two inches is deep enough to cover large grass-seed, while half an inch is deep enough for timothy and clover and other small seeds.

STAGE AT WHICH TO CUT GRASS FOR HAY

The proper stage at which the grasses should be cut for hay has been the subject of much investigation on the part of agricultural chemists. The general conclusion to which these investigations have led is thus stated by one of our most eminent investigators: "Young plants while rapidly growing contain relatively more protein and less fibre than more mature ones; consequently, early cut fodder must be of better quality than that cut late. It is more digestible." We have here three facts and one inference. As the point is one of much practical importance, we will consider it at length. First, the facts are:

A. Young, growing plants contain relatively more protein than mature ones.

B. They also contain less fibre.

C. They are more digestible.

The inference from these facts is: Early cut fodder is of better quality than that cut late. Is this inference justified? Concerning the first fact, it may be stated that we do not grow the ordinary grasses for the protein they contain, and the fact that mature

grasses have a smaller percentage of it than immature ones is a matter of small importance. We can get portein more cheaply than by cutting immature grasses for it, when by doing so we lose considerably in yield and, perhaps, also in palatability. Especially in the South and the Far West, where the ordinary feeds are too rich in protein, is this conclusion not well founded. Even in the Timothy Region proper we can get protein in a more satisfactory way.

The second and third facts (*B* and *C* above) are closely related, and may be considered together. Careful digestion experiments are not sufficiently numerous to show definitely that timothy cut, say, when the seed are in the dough stage, is decidedly less digestible than when cut, say, just before bloom. But grant that there is a difference; is it sufficient to compensate for the smaller yield and lower palatability of the early cut hay?

The fact is that old, experienced feeders and hay dealers almost invariably prefer timothy hay that has been cut after the seed is pretty well formed. They insist that stock like it better, and that it is a stronger feed than hay cut earlier. There is a possibility that investigators have paid too little attention to one of the most, if not the most, important factors in determining the value of a given feed—namely, its palatability. Considering the comparatively small variation in the chemical composition of the same grass cut at different stages, the most important question is not how nutritious is a pound of it, but how much of it will an animal eat. We are all well aware that a feed has little value in most cases if stock will eat it only

when driven to do so from hunger. It is that which is eaten over and above a maintenance ration which is of real value both for work and for animal products. Is it not better to cut hay at the stage when it will be most readily eaten, and then balance up the ration by a judicious combination of feeds of different compositions? The writer believes this to be the case, and what is said below is based largely on the assumption that the best stage at which any grass should be cut is determined largely by palatability and yield.

There is yet another factor which is really more important than the variations in chemical composition, and that is the effect on the digestive organs. Grasses cut very green are laxative in character, while those cut ripe tend to produce constipation, and this is sometimes the determining factor in cutting hay. In practice, therefore, the factors which determine the stage at which a grass should be cut for hay are yield, palatability, and effect on the bowels. In particular instances considerations which are ordinarily minor ones become important. In the case of Johnson grass and wild oats, for instance, both of which are vile weeds, yet excellent hay when cut at the proper stage, it is of the utmost importance to cut the hay before any seeds are mature enough to germinate. In this case all other considerations vanish. If the weather or the pressure of other work never interfered with haymaking, these two plants would undoubtedly be highly valued and standard crops, for they could then be cut at a stage which would prevent them from scattering by seed. Johnson grass presents another peculiarity of some importance. It yields three crops a year or-

dinarily. The second and third crops come on evenly, so that all the grass is practically at the same stage when cut; but the first crop is liable to be very irregular, and much of it will therefore have to be cut before it heads out in order to avoid ripe seed in the more advanced plants. The time to cut this grass is when the earliest portions of the field begin to bloom. Wild oats should also be cut while in bloom. In the case of timothy and most common grasses we are not bothered with weedy character, and can therefore give our whole attention to the quality and yield of hay.

Horses prefer timothy cut when the seed is well formed but not fully ripe. As this class of stock is unfavorably affected by laxative feeds, late cut timothy is also preferred for them on account of its favorable effect on the digestive tract. In the case of cattle, laxative feed is rather to be preferred. Cattle also relish timothy better when it is cut rather green. Hence, for cattle, timothy should be cut about the time it is in blossom. Any time from a day or two before the "first bloom" till a day or two after the "second bloom" will answer. (For the meaning of first and second bloom, see Chapter VI.) The yield will be slightly larger at the later stage.

Orchard-grass loses its palatability very rapidly after blooming, and should always be cut within a day or two after the blooming period is past. Brome-grass, which is becoming an important grass in this country, retains its palatability until the seed is dead ripe. Even the straw from which the ripe seed has been threshed is eaten readily by both cattle and horses. It therefore has a considerable season during which it

may be cut for hay. The same is true of blue-grass, Bermuda grass, and Italian rye-grass. There is doubtless a best time to cut each of these, but that depends on yield mostly. In the case of grasses that yield a second cutting, like the last two mentioned, the earlier the first cutting is made the larger the yield of the second cutting will be.

The time of cutting of other grasses is discussed in sufficient detail in later chapters.

CURING HAY

The best hay is made without rain and with the least possible sunshine. If it were practicable to cure hay in the shade, the quality would be all the better. The curing of hay is a process of drying and of fermentation. Hot sun tends to stop the fermentations which produce hay of good flavor. It is important, therefore, to rake the hay into windrows as soon as it can safely be done. When the growth is light, as is usually the case with such grasses as blue-grass and redtop, and frequently with Bermuda grass, it may be raked up within two hours after cutting, providing, of course, the weather is dry. Heavier growths require a longer time, sometimes one or two days, and frequently the use of a tedder is necessary to dry out a heavy growth of hay evenly, so that the upper portion of the swath may not become sun-baked and dead while the under portion is still fresh and green.

When any given process can be reduced to definite rules, such rules may largely take the place of experience; but in haymaking experience is necessary in

order to be able to know at what stage to perform the necessary operations. Only the most general rules can be laid down. In most cases, as much as possible of the curing should be done in windrows or cocks. After the hay is cocked up there is not so much need for haste, unless there is danger of rain. It is good

FIG. 4—HAYING SCENE IN NOVA SCOTIA

policy, however, to get hay in stack or mow as soon as it is dry enough not to mould. The color and flavor will be the better the less rain and sunshine the hay gets after it is cut. By referring to the grades of hay in the last chapter, it will be seen that color is a leading factor in its classification. Not that color of itself is essential, but it is the most important indication of the manner in which the curing was done. As

a rule, the less change that occurs in color during the curing the better the hay will be.

How long to leave hay in the cock cannot be determined by any general rule. It depends on the kind of hay, the stage at which it is cut, the dryness of the atmosphere, and the weight of the crop. A heavy crop takes longer to cure than a light one. Timothy cures quickly, while millets require a longer time. A rule frequently followed by farmers is to begin stacking when the hay in the center of the cock is dry enough that when a wisp of it is twisted no juice can be squeezed out of it.

When a large quantity of hay is put in a single mow or stack it may be stored in a greener state than when the quantity is small. Some farmers put clover hay in the mow right from the mower. In storing hay as green as this they usually put about a gallon of salt on each ton of hay. Some use a half gallon of quicklime instead of the salt. The salt or lime absorbs moisture from the hay, and thus aids the curing process. Hay stored before drying generally turns brown, or even black, in curing, but it is readily eaten by stock. The writer has never practiced this method of bulk-curing, though it is frequently reported in the agricultural papers. Hay cured this way is close kin to silage.

The method of curing hay (timothy and clover) used by the Rev. J. D. Detrich, formerly of Flourtown, Pa., who probably raises the largest crops of hay of any farmer in this country, is given in his own words, as follows: "The grass is cut in the afternoon. The first night's dew never hurts it. The next day it is

left to lie until noon. It is then put into curing cocks, which are made flat. The cocks are upset the next morning, and in the afternoon four of them are made into one weathering cock. Thus it is allowed to remain for one day, and then hauled to the barn or rick."

FIG. 5—RAKE FOR MOVING HAY-COCKS TO STACK

This gives three days from cutting to hauling. The quality of this hay is unsurpassed.

STACKING AND BALING

In stacking hay, especially if it is to remain long in the stack, it is important to place the hay so that it will settle evenly, and more so near the margins than at the centre. This is accomplished by dumping the forkful in the centre of the stack, and then distributing it evenly, keeping the middle a little high. If the rick form is used the fork should be dumped along

the middle, and care should be used to distribute the hay so that the whole central line of the rick is equally compressed. Neglect of this precaution will cause the centre to sag in places and leak rain into the centre of the rick. (A stack made too flat is shown in Fig. 6.) The stack or rick should have some kind of

FIG. 6—A HAY-STACK MADE TOO FLAT

foundation to prevent decay from contact with the ground. A layer of dry straw a foot deep will answer for this, but a foundation of boards or fence-rails is better. After the stack is about two-thirds as high as it is desired to make it the middle should be considerably raised and kept high till it is finished. This will cause the hay to settle so as to shed rain better.

It is usually necessary to anchor the stack to prevent the top from blowing away in strong winds before

it is well compacted. A good plan is to tie weights to the two ends of a rope and hang this over the top. Two such ropes crossed at right angles will hold a stack in ordinary winds, and one such rope about every six feet on a rick will answer the same purpose.

Little need be said regarding the baling of hay. It

FIG. 7—HAY-DERRICK IN COMMON USE IN UTAH

is unnecessary to bale hay that is to be consumed on the farm or sold for local consumption. Hay that is to be shipped must be baled to reduce its bulk and make it more convenient to handle. The size of the bale is determined by the requirements of the markets in which it is to be sold. One hundred pounds is the usual size, though some markets require bales smaller and some much larger. On the Pacific Coast, where

considerable hay is baled for the export trade, a great deal of it is double compressed. The ordinary bales are put into a hydraulic press and the size is reduced about one-half, so that a ton of double-compressed hay occupies only fifty-five cubic feet, or a cubic space less than four feet each way. Hay thus compressed secures lower freight rates than that in ordinary bales. The practice of baling from the cock, or even from the windrow, is becoming common in some sections, especially on the Pacific Coast, where fine weather is always assured in the haying season (except near the ocean). When baled direct from the cock or windrow it is necessary to let the hay get a little dryer than it needs to be for stacking to avoid heating in the bales, and the bales should not be closely bulked until they have had time to "go through the sweat."

GRAZING THE AFTERMATH

It is a common practice in this country to allow stock to run on the meadow after the hay is off unless it is desired to cut a second crop. In this case stock is usually turned in after the last crop is off. (Timothy makes only one crop of hay, while clover makes two, and alfalfa three or more in a season.) In the North there is little harm in this if the number of animals is not too large. It is always unwise to let stock eat a meadow down very close, especially late in the fall. The meadow is much more liable to injury from cold in winter when left bare. It is decidedly bad policy to turn stock on a meadow in wet weather, for they puddle the soil and cut up the sod with their hoofs. Timothy should never be pastured close, for it

is killed by too close cropping. In the Middle South a good meadow of the ordinary grasses, such as timothy, orchard-grass, fescue, and redtop, should never be pastured at all, and a Bermuda-grass meadow must not be pastured late in the fall. If it is, it is liable to freeze out. Johnson grass will not stand pasturing to any extent. If pastured at all closely it becomes patchy.

IV

MEADOWS AND PASTURES (*Concluded*)

LONGEVITY OF MEADOWS

THE length of time a meadow will last depends on the grasses of which it is composed, on the climate and the character of the soil, and on the treatment it receives. Meadows of Bermuda grass, blue-grass, or alfalfa last almost indefinitely with proper treatment, and remain as prolific as at first; in fact, they increase in productiveness for some years after they are laid down. Meadows of other grasses usually produce their largest yield the first year a crop is obtained, and will drop to about half this amount in one or two years more unless well manured. Even with good manuring, meadows of the common hay grasses of this country seldom remain as productive as they were the first year. Most of our meadows become weedy in a few years. A weedy meadow is an eyesore on any farm. The best remedy is to plow it up and run it through the regular rotation, so as to give a chance to destroy the weeds. If it is good arable land, and is not in blue-grass, Bermuda grass, or alfalfa, the best plan is to keep meadows down only two years, unless they are wanted for pasture for a year or two longer. It is, of course, recognized that special conditions may render it desirable to keep a meadow down for a longer time. If

this is the case, it should be well fertilized and kept free from weeds.

PASTURES

Much of what has been said concerning meadows applies as well to pastures, and need not be repeated here. There are two really great pasture-grasses in this country—the blue-grass of the North and the Bermuda grass of the South. To these we may add brome-grass of the Northwestern Prairie States. These are discussed in later chapters. Practically all the meadow-grasses are used more or less for pasture purposes ; in fact, there is scarcely a crop grown in this country that is not utilized to some extent for pasture. In California herds of sheep graze the leaves and tender shoots on grapvines after the fruit is harvested. In the South cattle are frequently turned into the cotton-fields at the end of the season, where they eat the leaves and immature bolls of the cotton-plant. All the cereals are used extensively for winter pastures, particularly in the South, for which purpose they are extremely valuable. All over the country stubble-fields and stalk-fields are pastured after the grain is harvested. Green crops of every description, including corn, sorghum, rape, etc., are more or less used as pastures, and when properly managed they furnish more abundant forage than the ordinary hay and pasture grasses.

In the more thickly populated sections of the country, especially on the better class of lands, there is a marked tendency to confine permanent pastures to rough land or land otherwise unsuited to cropping. It is contended that the amount of feed secured from such pasture-land is so small that the farmer cannot

afford to devote good land to this purpose. There is much truth in this contention, particularly in view of the usual method of pasturing in this country, which is to throw all the pasture-land into a single inclosure and turn all the stock upon it. When land is pastured in this manner, if it is stocked sufficiently to keep the growth down, the yield of forage is small, for a small plant does not make as much growth in a day as a large one. On the other hand, if the amount of stock is too small to keep the growth eaten down, much feed is wasted by trampling, and the grass is eaten closely in some places, while it is left to grow rank and coarse in others.

The Michigan Experiment Station some years ago determined the relative yield of forage on grass-plats, part of which were kept closely clipped, in imitation of pasture, the remainder being treated as meadow, and cut when more fully mature. The yield of forage on the plats treated as meadow was three to four times that of the others. This agrees with the experience of farmers that meadows produce more feed than the same area in pastures. The practice of devoting only rough lands to permanent pastures, therefore, seems to be justified—at least in sections where farm-land is high-priced.

Methods of pasturing prevail in many parts of Europe by which much more feed is obtained from the land. There cattle are frequently tethered in such manner that the area they can graze is only sufficient to furnish feed for one day. The next day they are moved far enough to secure another day's feed. In this way grass is eaten clean, and there is little or no

waste from trampling. This method also permits the grasses to grow to proper maturity, so that the amount of growth is a maximum. Another method of accomplishing the same end is to divide the pasture by means of temporary or permanent fences, and allow the stock to remain in one inclosure till the grass is closely eaten before admitting them to the next. Meanwhile the herbage in the inclosure first pastured is allowed to grow up again before it is eaten down a second time. Both of these methods require much attention from the herdsman, and are hardly practicable on farms where beef production is a prominent feature. One or the other of these intensive forms of pasturing might be practiced with profit with dairy cows, sheep, or hogs. Both of them are close kin to the method of soiling.

In many parts of the country the cereals are used extensively for pasture with excellent results. This is particularly the case in the South. Oats are used more frequently for this purpose than the other cereals, though in part of western North Carolina, and adjacent regions in adjoining States, a Southern variety of rye is used extensively. Around Sherman, Texas, a winter variety of barley has recently gained much favor, and is extensively used for winter pasture. It is said to yield more abundant feed than oats, rye, or wheat, while stock eat it with greater relish. In favorable seasons—that is, when there is no drouth to check growth—any of the cereals sown the middle of September in the South will furnish considerable feed by the first of November. Stock may be kept on these pastures till in the spring, when the grains begin

to throw up seed-stalks, after which, if the stock are removed, a fair crop of grain may be harvested.

Good temporary pastures may be made in the North in summer by sowing winter cereals in the spring. A true winter cereal, if sown in spring in the North, will not head out that year, but will produce a fine growth of leaves which stock eat with a relish. They may also be pastured the following winter, and then produce a crop of grain the next spring if the stock is taken off early enough, except in the case of wheat, which is destroyed by the Hessian fly when sown in the spring and left over till next spring. For this reason, when winter wheat is sown in spring and used for summer pasture, it should be plowed up in the fall.

When the cereals are used for pasture, particularly on clay soils, greater care should be taken not to allow stock on the field in wet weather than when pasturing grasses that form a dense sod. A clay soil may be practically ruined by the trampling of stock in wet weather, even where it has a good sod to protect it.

PASTURE MIXTURES

If questions concerning farm practice could be solved with pencil and paper, the problem of the best pasture mixtures would have been solved long ago. It is easy to figure out mixtures that *ought* to give abundant pasture from early spring till snow flies, and, in the South, the year round. This has been done repeatedly for the American farmer, but he still sticks to his blue-grass and white clover or his Bermuda grass, as the case may be, thus depriving his stock of pasture

for a considerable portion of the season of possible pasture. Whether the trouble lies with the farmer or with the mixtures it is not possible to say. Both are probably to blame—the farmer for not giving the mixtures a more extended trial, and the mixtures for not giving better results when they are tried. Usually, when the American farmer wakes up to the fact that he is not getting sufficient income from his pastures, he abandons the use of pastures as much as possible instead of trying to make them productive enough to pay. There is room for a lot of demonstration work on this subject at the experiment stations. The methods used in Europe ought to be given a thorough trial here. Until this is done a good many people will always believe that the productiveness of English grass-lands could be duplicated here. There are some parts of the country in which blue-grass and Bermuda grass are quite satisfactory as pasture. There are many places where they are not. The use of brome-grass and alfalfa as a pasture mixture is mentioned elsewhere in these pages. This mixture deserves a fair trial over all parts of the timothy region where blue-grass is not highly productive. Mixtures of timothy, redtop, orchard-grass, tall fescue (the kind grown in Eastern Kansas), blue-grass, Canada blue-grass, and the clovers, including alfalfa, deserve to be tried extensively all over the northern half of the country for permanent pasture. Until this is more generally done it is impossible to state what the result would be. The writer believes a mixture of all the above varieties named would furnish more pasture in many parts of the country than the common mixtures do.

There are only about four States of the Union that have as much as 50 per cent. of their area improved. Whatever may be said of the advisability of keeping good arable land in pastures, a great deal of this unimproved land could be made into fairly productive pasture. In the blue-grass country this can be done by clearing off the rubbish, burning the leaves and litter, and scattering seed of such grasses as blue-grass, white clover, orchard-grass, and redtop. On rough hill land on the farm belonging to the Missouri Experiment Station, which, during the writer's schoolboy days, was covered by a dense growth of blackjack and postoak timber, there are now fine blue-grass pastures made in this manner. The productiveness of such pastures can be continued by keeping them free from brush and weeds.

WEEDS IN MEADOWS AND PASTURES

Weeds may be divided into three classes—namely, annuals, or biennials, which die root and branch when they have made seed; ordinary perennials, which die down to the ground in the fall, but the roots of which remain alive for several or many years; and perennials with creeping, or underground, stems, whose aerial stems die at the approach of winter, but whose underground stems live over.

The way to eradicate an annual or biennial weed is to prevent it from making seed. The seeds of some of them may live for many years in the soil and send up a new crop of weeds annually. If they be cut back persistently, so that no new seed is formed, they can finally be eradicated. The hardest weeds of this class to handle are those which, when cut back, produce seed

on short branches near the ground. They must be treated as the ordinary perennials.

Ordinary perennial weeds must be cut off below the crown. This requires the use of the hoe, the spud, or, where very numerous, the turning-plow, which, of course, means reseeding the meadow or pasture. Perennials with underground stems are the most difficult to deal with. Quack-grass (Fig. 8), Johnson grass, and Canada thistle belong in this class. The surest way to kill them is to harrow out as large a proportion of the roots as possible, and then summer-fallow the land, running over it as often as the weeds get a start with some implement that shaves off a layer of the top soil. Weeds of this class that do not grow very tall may be smothered out by such dense growing crops as millet, buckwheat, sorghum (sown thick), etc. Such weeds may also be killed by cutting them back so frequently that they have no chance to manufacture and store up food enough in their underground stems to keep them alive.

The weeds which infest grass-lands vary in different sections. In the North, whiteweed (*Erigeron philadelphicus*) is one of the most troublesome. In pastures this can be held in check by mowing, but when a meadow becomes infested with it the best remedy is to plow it up. Sorrel (*Rumex acetosella*) is probably the next most troublesome weed in grass-lands in the North. It is particularly troublesome in old grass-lands, and its presence is believed to indicate an acid condition of the soil. A good application of lime, to correct acidity, and manure or fertilizer to produce a vigorous growth of the grasses and clovers, is said to

FIG. 8—QUACK-GRASS

be the remedy for it. Sorrel seldom appears in grass-lands that are so treated as to keep up a vigorous growth. Its presence is a pretty good indication that it is time to plow up the sod and run it through a rotation which will give an opportunity to kill weeds and put the land in good heart. Some old timothy meadows are much overrun with plantain, especially on worn soils where the grass makes a feeble growth. It is unwise to keep meadows down on such soils after plantain becomes troublesome.

In middle latitudes and in the Southern States broom-sedge (*Andropogon virginicus*) is probably the most troublesome weed in grass-lands. It may be kept out by prompt removal with the hoe or spud as soon as it appears. Broom-sedge does not bother on land kept in condition to grow a good crop of grass, and causes trouble only in meadows and pastures several years old. When young and tender, stock eat it fairly well, and this has a tendency to hold it in check in pastures. When it becomes plentiful in a meadow, the best plan is to break up the land and grow a cultivated crop. Brome-sedge does not invade land that is plowed once or twice a year.

Bitterweed (*Helenium tenuifolium*) is very troublesome on over-stocked and poorly fertilized grass-lands in many parts of the South. It is particularly objectionable on dairy farms, since it affects the flavor of milk very unfavorably. To get rid of it fertilize well and reduce the number of stock kept on a given area, so as to give the grass a chance to run out the weed. Being an annual, it may also be killed by preventing it from making seed.

On the Pacific Coast a species of fern (*Pteris aquilina*) is the worst weed in grass-lands, particularly west of the Cascade Mountains, in Washington and Oregon. It is provided with rather formidable underground stems, and is difficult to eradicate. It may be held in check by cutting twice or three times a season. When young and tender, sheep and goats will eat it, and it may be eradicated by stocking the land heavily with these animals. It does not bother much on land that is plowed eight or ten inches deep once a year, and hence is not very troublesome on well-cultivated fields.

MANURING GRASS-LANDS

The use of fertilizers is one of the most unsatisfactory subjects to handle in the whole range of agricultural science. It is now just one hundred years since the first carefully planned fertilizer experiments were laid out by a modern investigator. Sixty-two years ago Liebig's great work was published, in which the theory was announced that by analyzing the soil and the crop the chemist could prescribe the fertilizers to be applied in any given case. This theory was the basis of the work of the agricultural chemists for half a century. Innumerable fertilizer experiments have been conducted with the utmost care. The soil has been analyzed times almost without number. The constitution of the mineral matter removed from the soil by plants has been determined to a nicety. It is definitely known that chemical fertilizers frequently, we may say usually, exert a decidedly favorable influence on growing crops. It is absolutely impossible, however, to say just what fertilizers or how much of

them should be applied in any given case with assurance that the application will be profitable. It is fairly certain that fertilizers do not produce much effect on soils that are not pretty well supplied with decaying vegetable matter, except in the case of certain sandy soils that are always in good mechanical condition. Dr. E. H. Jenkins, of the Connecticut State Experiment Station, after a lifetime spent in conducting fertilizer experiments, and after reading the results of practically all the experiments of this kind that have been published, both in Europe and America, at a recent gathering of agricultural chemists said: "The only recommendation I can make with confidence is that barn-yard manure is a good thing to put on land."

While we know that many farmers in the older sections of the country are using fertilizers with profit to themselves, it is necessary for every man to depend largely on his own experience in this matter. It requires long years of experimenting to arrive at reliable conclusions regarding the use of fertilizers. Several of our experiment stations are doing splendid work in this line. In time we may hope that they will be able to give us safe rules to follow. Regarding the use of barn-yard manure on grass-lands it is possible to make positive recommendations; as to the use of commercial fertilizers, if one will take the trouble to read the recommendations of different authorities it will be seen that we are quite in the dark.

The farmer who probably produces the largest crops of hay in America makes the following statement concerning his practice in the use of fresh stable

manure on his meadows: "The grass-seeds are sown on well-prepared land in late summer. The land is manured before it is plowed for the grass crop. No top-dressing is used the first winter, as 'the young grass will not stand it.' The next winter the sod is top-dressed, as it is again the next. It is then plowed up for corn." Manure on this farm contains both the liquid and the solid excrement from the stock.

On farms where manure is not plentiful it is considered good practice to plow under a light dressing of manure in preparing land for grass. As a rule, no further dressing of manure is applied till the winter after the second haying season, when the sod is manured before breaking it up for corn. Ten to twelve tons of barn-yard manure per acre is generally considered a good dressing; four to six tons a light one.

Sir John Lawes, whose valuable investigations at Rothamstead, England, extended over more than half a century, in speaking of the application of fertilizers to permanent grass-lands, says: "A dressing of dung once in five years, with two hundredweight of nitrate of soda each year for the other four years," was the best practice.

Freer, another English authority, makes the following recommendations regarding the season of the year in which to apply manure and fertilizers to grass-lands: Barn-yard manure should be applied during winter, and not later than the last of February; phosphates and potash, by the first of March; ammonium sulphate, by the first of March; nitrate of soda, by April 15.

Professor Soule, of the Tennessee station, recom-

mends the application of fifty bushels per acre of well-slacked lime in preparing land for grass in that section. The lime should be applied to the land after plowing, and should be harrowed in. He recommends a top-dressing of fifteen tons of barn-yard manure per acre in addition to the lime, applied before sowing. If commercial fertilizers are used, apply 300 to 600 lbs. of a mixture consisting of 100 lbs. of sodium nitrate, 250 lbs. of acid phosphate, and 50 lbs. of muriate of potash.

Professor Lloyd, of the Mississippi station, recommends the following: Cottonseed meal, 800 lbs.; stable manure, 800 lbs.; kainit, 400 lbs.—composted, applied at the rate of 1 ton per acre, and plowed under; or, cottonseed meal, 500 lbs.; kainit, 300 lbs.; gypsum or slacked lime, 200 lbs.—applied after breaking, and harrowed in just before seeding. On sandy soils use 300 lbs. of phosphate instead of the kainit.

Professor Mell, of the Alabama station, recommends, in preparing grass-land, the use of stable manure; or, ground bone, 300 to 400 lbs.; cottonseed meal, 100 lbs.; nitrate of soda, 50 to 100 lbs.

Professor Killebrew, formerly of the Tennessee station, recommends the following application to be applied to grass-lands, presumably in early spring: Top-dress with 100 lbs. of nitrate of soda, and three weeks later with 100 lbs. of bone meal or superphosphate. Where there is clover, gypsum may be applied. Use stable manure freely after the fall rains begin; it is the best of all fertilizers for grass-lands in Tennessee.

V

THE SEED *

SEED PRODUCTION

THE production of grass-seed (not including clover-seed) for the year 1899 is shown in Fig. 9. This map is based on the returns of the United States Census Bureau, and shows the area where grass-seed is grown in this country. As each dot on the map represents the production of 10,000 bushels, only the centres of production where the raising of grass-seed is an important industry are indicated. The seeds of standard grasses are shown in Figs. 10 and 11.

The State of Iowa leads in this industry, and furnishes nearly one-half of the grass-seed grown in the United States. Timothy is raised over a greater area than any other of the grass-seeds, but its production on a large scale is confined to regions near the northern and southern boundaries of Iowa. Millet-seed is grown over a large part of the Mississippi and Missouri valleys, but the seed which is most sought, and known in the market as Tennessee grown, comes from a comparatively small area in the central part of Ten-

* By Edgar Brown, in charge of the Seed Laboratory of the United States Department of Agriculture.

FIG. 9—PRODUCTION OF GRASS-SEED IN THE UNITED STATES

nessee. The areas of seed production of the other grasses are more limited.

The famous blue-grass country about Lexington, Ky., furnishes most of the blue-grass seed, a small amount being saved in southern Illinois and along the border between Missouri and Iowa. Orchard-grass comes from near Louisville, Ky., on both sides of the Ohio River. (The method of gathering blue-grass seed

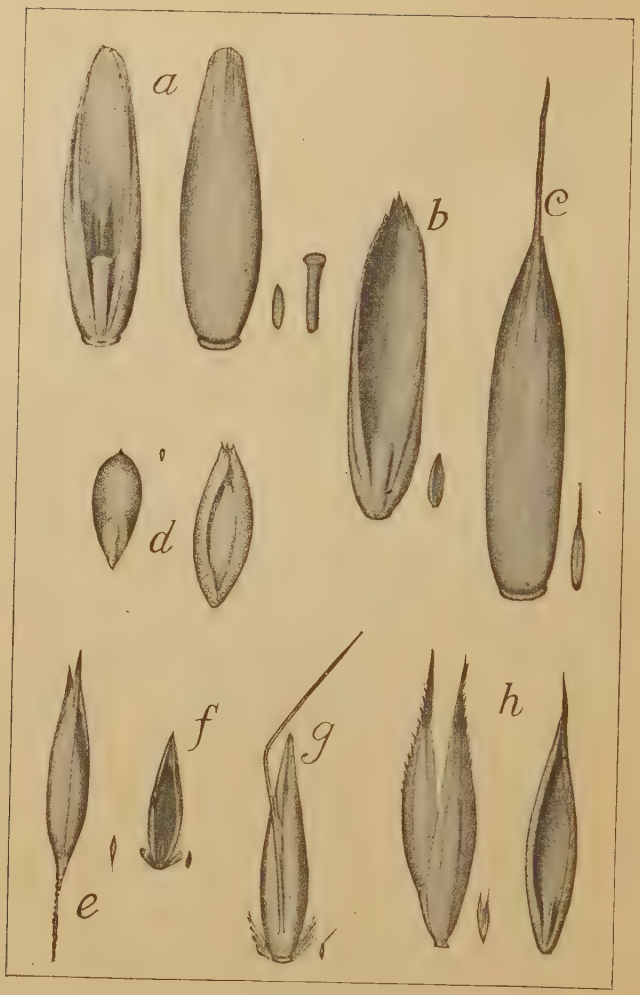

FIG. 10—SEEDS OF STANDARD GRASSES

a, Meadow-fescue; *b*, English Rye-grass; *c*, Italian Rye-grass; *d*, Timothy; *e*, Redtop in the chaff; *f*, Redtop, chaff removed; *g*, Rhode Island Bent; *h*, Orchard-grass. (G. H. Hicks, Year-book, Department of Agriculture, 1898.)

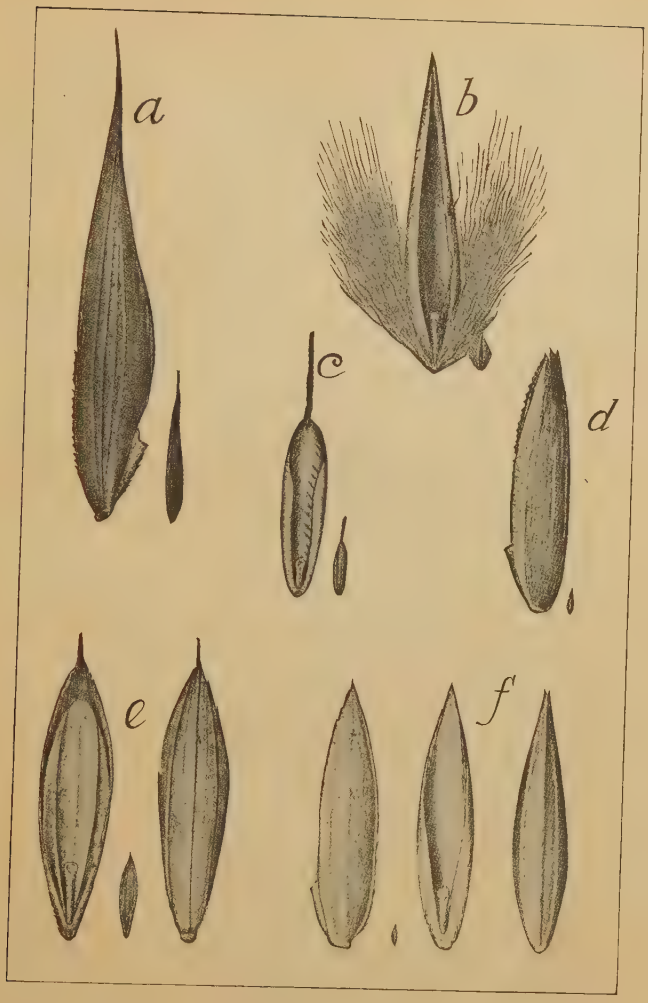

FIG. II—SEEDS OF STANDARD GRASSES

a, Rescue-grass; *b*, Texas Blue-grass; *c*, Chess, or Cheat; *d*, Canada Blue-grass; *e*, *Bromus inermis; f*, Kentucky Blue-grass. (O. H Hicks, Year-book, Department of Agriculture, 1898.)

is seen in Fig. 12, and of curing it in Fig. 13.) Southern Illinois furnishes nearly all the redtop seed, a small amount coming from southern New Jersey. Marshall County, in northern Kansas, produces practically all of the meadow-fescue seed. A little Canada blue-grass is saved in western New York, but the bulk of it comes from the flat clay country along the northern shore of Lake Erie, west of the Niagara River. Aside from Canadian timothy, orchard-grass and *Bromus inermis* are the only standard grass-seeds which are imported in any quantity. During the year ending June 30, 1904, 180,239 lbs. of New Zealand orchard-grass were imported, and during the same time 298,654 lbs. of *Bromus inermis*, mostly coming from Russia through Germany. *Bromus inermis* is raised extensively in Minnesota and the Dakotas, and down the Red River Valley into Manitoba. Johnson grass seed is raised along the Gulf, from Alabama to Texas. Bermuda grass seed is all imported from Australia, none being raised in the United States. As this grass is becoming more favorably known, the amount of seed imported is increasing annually. English and Italian rye-grass seed mostly comes from Scotland and Ireland. The seed of the less common grasses, such as tall fescue, sheep's-fescue, the bent grasses, and sweet vernal, are not saved in this country to any extent, but are imported from the Continent of Europe, mostly from France and Germany.

COST OF SEEDING DIFFERENT GRASSES

The cost of seed sufficient to sow an acre of various grasses is shown in the following table. The prices

FIG. 12—GATHERING KENTUCKY BLUE-GRASS SEED

are taken from the current catalogue of a well-known seed house, and are there quoted for seed in hundred-pound lots. The quantity of seed to sow per acre, shown in the first column of figures, is in some cases less than half that recommended in the catalogue:

COST OF SEED PER ACRE

	Lbs.	*Price Cents*	*Cost per Acre*
Timothy	15	6½	$ .97½
Italian rye-grass	25	8	2.00
English rye-grass	25	8	2.00
Redtop	16	15	2.40
Meadow-fescue	20	14	2.80
Brome-grass	20	16	3.20
Canada blue-grass	30	12	3.60
Orchard-grass	24	19	4.56
Kentucky blue-grass	40	16	6.40
Tall oat grass	30	25	7.50
Tall fescue	25	45	11.25

The low price of timothy is due largely to its good seed habits, because of which so much of this crop is grown as to render the seed a standard article of commerce. On account of the low price, together with the small size of the seed, it costs less than half as much per acre to seed with timothy than with any other cultivated grass.

The low cost of rye-grass seed is due to the great abundance of these seeds produced in England and on the Continent of Europe, where they are the leading grasses. The high price of tall fescue seed is due largely to the small amount produced. There is no intrinsic reason why it should command a higher price

FIG. 13—CURING KENTUCKY BLUE-GRASS SEED

than meadow-fescue. From the table it is seen that the cost of some varieties of seed, such as tall fescue and tall oat-grass, is so high as to be well-nigh prohibitive. This difference in cost undoubtedly has much to do with the lack of popularity of many grasses, even in sections where they are superior to others.

WEIGHT PER BUSHEL

In most trade centres the sale of seed by the measured bushel has been abandoned, and the much more satisfactory method of selling by the hundred pounds substituted. However, the weight per bushel is highly important as an approximate indication of quality, as it determines very closely the amount of chaff, although giving no information regarding weed seeds and adulterants. The recognized weights for the heavier grass-seeds, such as timothy and millet, represent a good grade, while with the lighter seeds, such as blue-grass, orchard-grass, and redtop, the weight per bushel of good seed is considerably heavier than that commonly used. In most States the legal weight of Kentucky blue-grass is 14 lbs., but well-cleaned seed of good quality weighs from 24 to 28 lbs. Orchard-grass, which is usually considered as 14 lbs., should weigh from 16 to 18 lbs. While chaff redtop often weighs 8 lbs. or less, good, solid, recleaned seed weighs 40 lbs. One of the best safeguards in buying the lighter grass-seeds is to have the dealer determine the weight per bushel, which should, in all cases, come up to the weight shown in the following table:

TABLE SHOWING THE WEIGHT PER BUSHEL OF GOOD QUALITY, WELL-CLEANED SEED OF THE COMMON GRASSES

	Weight per Bushel
Bent, Creeping	20
Bent, Rhode Island	15
Bermuda Grass	36
Blue-grass, Canada	20
Blue-grass, Kentucky	28
Bromus inermis	14
Fescue, Meadow	27
Fescue, Tall	24
Fescue, Sheep's	16
Johnson Grass	28
Meadow-foxtail	14
Millet, Common	50
Millet, Hungarian	50
Millet, German	50
Millet, Golden Wonder	50
Millet, Broom-corn	60
Orchard-grass	18
Redtop	40
Rye-grass, English	28
Rye-grass, Italian	24
Sweet Vernal	15
Tall Meadow Oat-grass	14
Timothy	45

WEED SEEDS

The weed seeds found in commercial seeds are not necessarily the most common weeds in the fields from which the seed is saved. Only those will occur which ripen at about the same time as the grass-seed and are not easily cleaned out. Grass-seeds contain, on the average, a much smaller percentage of weed seeds than

clover, but there are a number of kinds usually present. In timothy the two most common weeds are peppergrass (*Lepidium virginicum*) and false flax (*Camelina sativa*), the latter being abundant in Canadian seed and especially difficult to clean out. In addition to these, timothy often carries sorrel (*Rumex acetosella*), narrow-leaved plantain (*Plantago lanceolata*), green foxtail (*Chætochloa viridis*), five-finger (*Potentilla monspeliensis*), curled dock (*Rumex crispus*), and lady's thumb (*Chenopodium album*).

New Zealand orchard-grass contains more or less seed of velvet-grass (*Holcus lanatus*), and its presence may be taken as good evidence of the origin of the seed. Chess (*Bromus secalinus*), ox-eye daisy (*Chrysanthemum leucanthemum*), slender-rush (*Juncus tenuis*), peppergrass (*Lepedium virginicum*), narrow-leaved plantain, five-finger, and sorrel are also frequently found.

Kentucky blue-grass usually contains seed of some of the sedges (*Carex* spp.), slender-rush, and often shepherd's purse (*Capsella bursa-pastoris*), chickweed (*Cerastium* spp.), peppergrass, and sorrel.

Dealers frequently attempt to distinguish Canada from Kentucky blue-grass by running the hand into the seed to see if Canada thistle spines are present. As Kentucky blue-grass frequently contains spines of horse-nettle (*Solanum carolinense*), which closely resemble those of Canada thistle, this test cannot be relied upon and is apt to be misleading. Contrary to the common belief, Canada blue-grass seldom contains seed of Canada thistle, although the spines are usually present. While the seed is much easier cleaned than that of

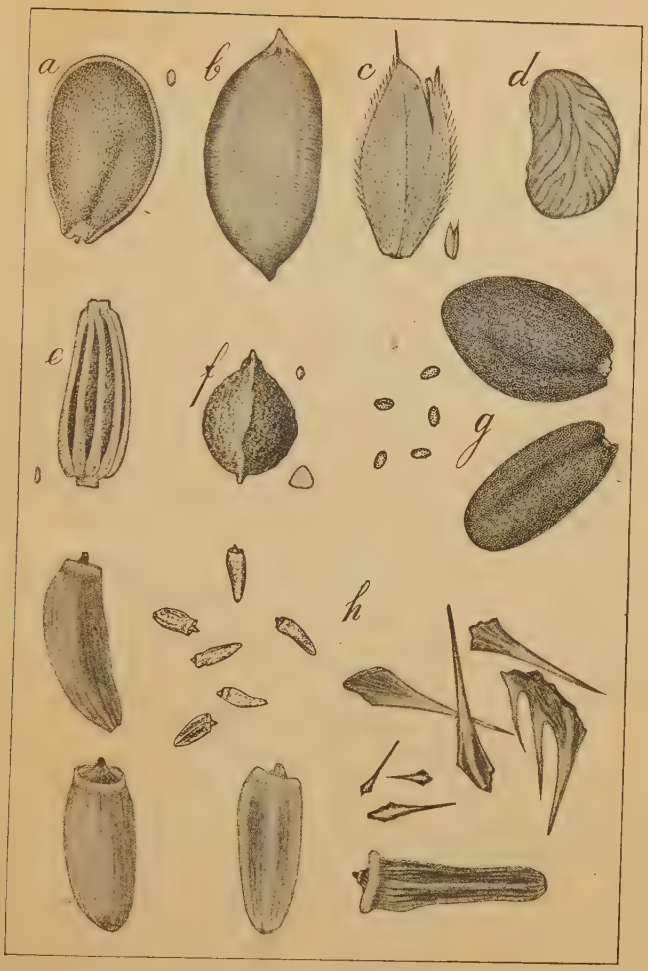

FIG. 14—WEED-SEEDS

a, Peppergrass (*Lepidium virginicum*); *b*, Slender Rush (*Juncus tenuis*); *c*, Velvet-grass (*Holcus lanatus*); *d*, Fivefinger (*Potentilla monspeliensis*); *e*, Oxeye Daisy (*Chrysanthemum leucanthemum*); *f*, Sorrel (*Rumex acetosella*); *g*, False Flax (*Camelina sativa*); *h*, Canada Thistle (*Carduus arvensis*).

Kentucky blue-grass, it often contains dog-fennel (*Anthemis cotula*), peppergrass, and five-finger.

Redtop seed usually contains but few weed seeds, among the most common being slender-rush and sorrel. (The seeds of some of the most common weeds are shown in Fig. 14.)

ADULTERATION

A few of our common grass-seeds are frequently and wilfully adulterated. The most important of these are orchard-grass and Kentucky blue-grass. Orchard-grass is most often adulterated with meadow-fescue, although English rye-grass is sometimes used. These seeds cost about half as much as orchard-grass, and resemble it so closely that the adulteration is only detected on close examination. The velvet-grass seed always found in New Zealand orchard-grass is harvested with it and not mixed intentionally.

But few seed-dealers can distinguish Canada from Kentucky blue-grass seed. These two resemble each other so closely that a careful comparative study with a hand-lens is necessary before a person can separate them.

When a buyer is offered two lots of seed as Kentucky blue-grass, one containing a large percentage of Canada, and the other pure Kentucky, he will usually choose the adulterated sample, because it is brighter and cleaner, and is offered at a slightly lower price. Although but little Canada blue-grass seed is sold as such in the United States, there is an annual importation of from 450,000 to 750,000 lbs., which is practically all sold as Kentucky blue-grass seed.

Rhode Island produces what little Rhode Island bent is harvested in this country. Considerable creeping bent is imported, and often substituted for the Rhode Island.

The seed of the annual sweet vernal is practically indistinguishable from that of the true perennial sweet vernal, and the use of the cheap annual seed as an adulterant is frequent. Redtop sells for about double the price of timothy, and very often redtop carries from 15 to 20 per cent. of timothy as an adulterant. The adulteration is likely to go unnoticed unless the sample is carefully examined.

GUARANTEED SEEDS

The selling of guaranteed seeds is practically unknown in this country. Instead, all of the principal seedsmen print on their seed packages and bills the following disclaimer clause, adopted by the American Seed Trade Association:

> "———— gives no warranty, expressed or implied, as to description, quality, productiveness, or any other matter of any seeds, bulbs, or plants we send out, and we will not be in any way responsible for the crop. If the purchaser does not accept the goods on these terms, they are at once to be returned."

The use of such a clause is in sharp contrast to the practice adopted by some of the English seed firms. For example, James Hunter, of Chester, England, prints in his price-list for 1904 a table showing the guaranteed percentage of germination, and the num-

ber of germinating seeds in a pound. The following are taken from his list:

KIND OF SEED	*Germination Per cent.*	*Germinating Seeds Number in 1 lb.*
Blue-grass, Kentucky	85	1,581,000
Meadow-fescue	99	233,640
Meadow-foxtail	90	441,000
Orchard-grass	95	404,700
Rye-grass, English	96	214,080
Rye-grass, Italian	98	264,600
Tall fescue	96	236,160
Tall oat-grass	90	124,200
Timothy	98	1,293,600
Sweet vernal	80	590,400

Since the American seedsmen give no form of guarantee with their seeds, buyers must determine for themselves the quality of seed offered for sale.

There is a great need for more regularly established seed-testing stations, where farmers may send samples of seed for analysis, and so know the relative value of seeds offered on the market, and consequently secure the quality of seed desired at a reasonable price.

SEED CONTROL AND SEED TESTING

While properly framed seed laws would tend to improve the quality of seed on the market, farmers are not helpless in the absence of such laws. Good seeds will be supplied whenever the buyer demands them if the dealer knows that what he offers is to be tested and the purchase made according to the result of the test. This is the system which has improved the quality of seeds in Europe, and any one can send samples to any of the numerous European seed-testing stations

and have tests made. Fertilizer inspection is so thoroughly established in the United States that many of the State agricultural experiment stations receive a considerable part of their income for their chemical department—at least, from the analysis of fertilizers. While a similar system of inspection may not be practical with reference to the sale of seeds, it is more important to know the quality of the seeds to be sown than the analysis of the fertilizer to be used.

The subject of seed testing has received little attention in the United States as compared with that given it in Europe. Hicks* says, under the heading, "Seed Control in Europe":

"European seed control may be said to have originated in 1869, when Dr. Nobbe, director of the experiment station at Tharand, Saxony, began to devote his attention to the impurities and low germinating power of many commercial seeds for which the German farmer was paying fancy prices. The publication of the results obtained by him excited much comment and laid the foundation for the present extensive system of European seed control. At the present time there are seed-control stations in all of the principal countries of Europe, more than forty existing in Germany alone. In some cases these are distinct institutions, but frequently this work is done in connection with agricultural experiment stations, the majority of which devote more or less attention to the subject. Some countries and States have general laws concerning fraud which may be used to cover seed adultera-

* Hicks, G. H. "Pure Seed Investigation." Year-book, United States Department of Agriculture, 1894.

tion, but, so far as we have been able to learn, there are no laws requiring English or Continental seedsmen to guarantee their wares. The work of the seed-control stations, however, has created such a public sentiment in favor of pure seed that the best class of dealers submit samples of their seeds to be tested by the stations, which furnish, for a stipulated price, a guarantee of the vitality and purity of the seed from which the samples were taken."

Several of the State agricultural experiment stations have given more or less attention to seed testing, but in most cases the facilities for doing the work are limited and the total amount done is small. In 1894 seed testing was begun by the United States Department of Agriculture, at Washington, D. C., and has been continued by the Seed Laboratory since that time. Samples of seed sent to this laboratory for test will be examined for mechanical purity and tested for germination free of charge for purchasers of seed, provided samples are accompanied by a statement giving the name and address of the firm from which the seed was purchased, and the price paid. While the farmer is able to judge the general quality of a sample of timothy by a careful examination, he is not able to detect adulterations of the less common grasses or estimate the per cent. of the seed which will grow.

HOME TESTING

Many of the more common grass-seeds, such as timothy, orchard-grass, and millet, can be tested for germination at home. The simple home-tester shown in Fig. 15 can be made and used by any one.

Mix the seed thoroughly and count out 100 or 200 seeds just as they come, making no selection. Put them between a fold of cotton flannel or some similar cloth, taking care not to let the seeds touch one another. Lay the cloth on a plate, moisten it well, but do not saturate it, cover with another plate, and keep

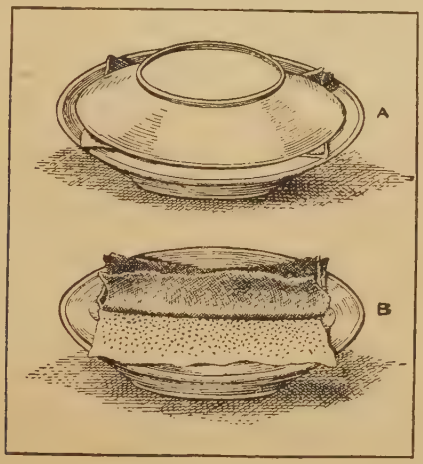

FIG. 15—HOME-MADE SEED-TESTER
A Closed; *B*, Open

in a warm room where the temperature will not go above 86° F. The cloth should be moistened from time to time, and the sprouted seeds counted and removed every day. Grass-seeds are not as easy to test as clover and many of the vegetable seeds, for they require much more exact conditions, needing an alternating temperature. If a sample of grass-seed tests well by use of the simple method mentioned above, it

is safe to assume that it will grow well if sown, but if it does not germinate well, the seed should not be condemned, as the conditions for germination may not have been right, and a sample should be sent for an official test, either to one of the State agricultural experiment stations, or to the United States Department of Agriculture, Washington, D. C. The following table* gives the temperature at which germination tests should be made, and the length of time required to make tests:

KIND OF SEED	*Temperature† Degrees, F.*	DAY FOR MAKING GERMINATION REPORT	
		Preliminary	*Final*
Bermuda grass	68–95	10	21
Blue-grass	68–86	14	28
Brome-grass	68–86	5	10
Meadow-fescue	68–86	5	10
Millet	68–86	3	6
Orchard-grass	68–86	6	14
Redtop	68–86	5	8
Rye-grass	68–86	6	14
Timothy	68–86	5	8

* Circular No. 34 (revised), Office of Experiment Stations, United States Department of Agriculture, "Rules and Regulations for Seed Testing."

† Seeds should be kept at the higher temperature for six hours, and at the lower temperature for eighteen hours each day.

VI

TIMOTHY (*Phleum pratense*)

TIMOTHY (Fig. 16) is frequently known as herd's grass in New England, though elsewhere, especially in the Middle and South Atlantic States, this latter name is applied to redtop. Timothy is by far the most important hay grass in America. In spite of the fact that chemists tell us it is one of the least nutritious of the grasses, timothy, or mixtures in which it is the leading constituent, constitutes nearly three-fourths of the total area of tame hay and a much larger proportion of the market hay of the country. Even in the South, where it is not grown to any considerable extent, it is the principal hay on the markets of all the larger cities; in fact, no other true grass is recognized as a standard hay, except in restricted localities. There must be some reason for this apparent discrepancy between the chemical composition of timothy hay and its standing on the markets.

In the first place, this grass has the best seed habits of any hay or pasture plant known. The seed from an acre of it will sow a larger area than almost any other grass. The seed is easily harvested and retains its vitality remarkably well. Being entirely unlike any other common seed, both in size and appearance, its purity can readily be judged by the farmer.

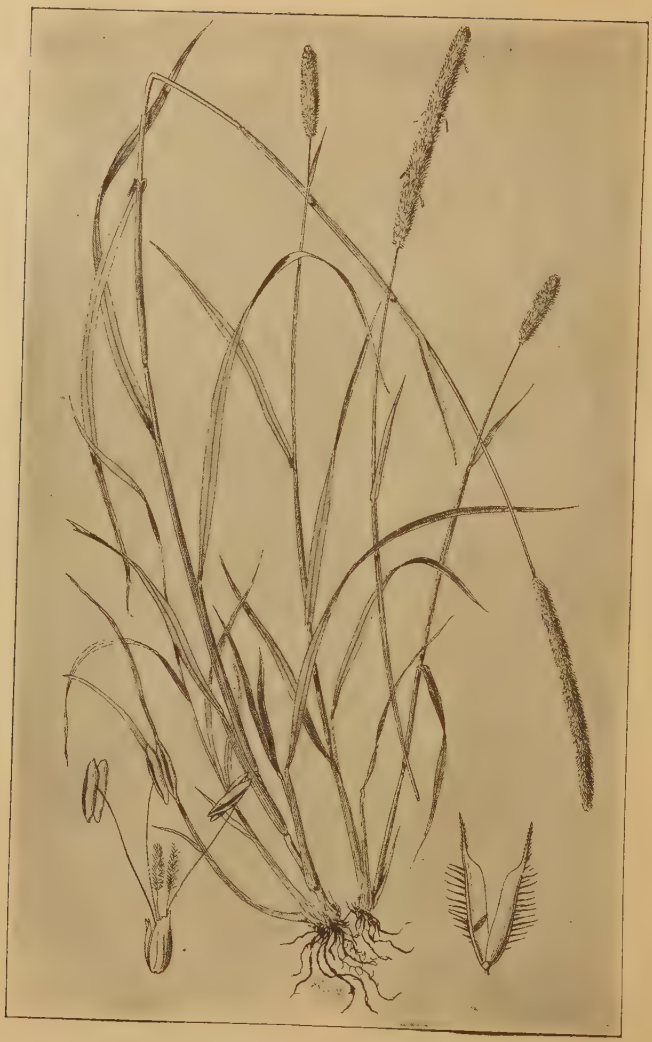

FIG. 16—TIMOTHY

The hay is easily cured, bears handling well, and may be cut any time between blossoming and the ripening of the seed with comparatively little difference in the quality of the hay—at least, for horse feed. For these reasons, farmers prefer timothy to other grasses. On the other hand, timothy hay is exceedingly palatable, particularly to horses, and it is the demand for horse feed in the cities that fixes the price of hay in this country.

Again, horses that are kept for hire are frequently driven to the limit of endurance after a full feed. Such horses must have feed that will digest readily and not produce derangement of the digestive organs under these circumstances. For this purpose timothy hay has no equal. It is also probably true that too much stress has been placed by recent writers on the need of protein (nitrogenous material) in feeding-stuffs. A few years ago it was frequently the custom to value feeding-stuffs by the amount of protein they contained. Timothy, being low in nitrogenous constituents, was said to have little nutrition in it. It should be remembered, however, that an idle animal needs very little protein, while an animal at work usually gets the bulk of its protein from grain. Experience has abundantly shown that timothy hay alone is an excellent ration for an idle horse, or even a horse with moderate exercise. These facts seem to justify the important place that this grass occupies in American agriculture. There are circumstances under which other grasses deserve much more attention than they thus far have received in this country, as indicated elsewhere in these pages.

The outstanding importance of timothy is due largely to the fact that, except in the alfalfa regions of the West, nearly all our hay is produced in the region to which timothy is best adapted. Perhaps hay production may be largely confined to the timothy region because no other grass has been found capable of taking its place in other sections. Certain it is that, except in the Far West, hay production and live-stock farming are nearly confined to the region of timothy, clover, and blue-grass, all of which have nearly the same distribution.

The lack of forage plants and grasses, and, consequently, of live stock, in the Southern States is probably due more to the cotton-plant than to any other one cause. Should the cotton boll weevil render cotton unprofitable in the South, there is abundant reason to believe that plenty of good grasses may be grown to make stock-raising profitable south of the timothy region. It is an interesting fact, referred to earlier in these pages, that nearly all the grass literature issued by the experiment stations of this country comes from those States that lie either on the border of the timothy region or entirely outside of it. In the timothy region (where clover and blue-grass also abound) the grass question ceased to be a pressing one before the experiment stations were established.

Fig. 17 shows approximately the distribution of timothy in this country. This map was constructed as follows: On a county map of the United States a large dot was placed in each county showing over 5,000 acres of "other tame grasses" (mainly timothy, and mixtures in which timothy is the leading constituent),

FIG. 17—DISTRIBUTION OF "OTHER TAME GRASSES," MOSTLY TIMOTHY

according to the census of 1900. In counties having from 500 to 1,500 acres, a small dot was placed; two small dots were placed in counties having from 1,500 to 2,500 acres, and so on. The border of the real Timothy Region is thus seen to traverse central Delaware and central Maryland. It includes in the timothy region the mountainous parts of Virginia, a small portion of northwestern North Carolina and of northeastern Tennessee. Southwestern West Virginia is excluded. Thence the line runs irregularly through northern Kentucky, southern Illinois, and southern Missouri. Thence it runs northward, including one tier of counties in southern Kansas and three tiers in the north, and cutting across the southeast corner of Nebraska. It then follows the west line of Iowa, nearly to Minnesota, after which it takes an irregular course across Minnesota and Wisconsin. Timothy does very well in the eastern parts of Kansas, Nebraska, and the Dakotas, but the enormous quantities of wild hay cut in those States (see Fig. 3) renders timothy comparatively unimportant there. A few large dots, scattered here and there near the border line, and quite generally in the Northern Rocky Mountain and Pacific Coast States, indicate centres in which timothy is more or less important. South and west of this border line timothy is of little importance, with the exceptions noted. It cannot stand the summer climate of the South, nor the arid or semi-arid conditions of the West. North and east of this line it has heretofore been the one great hay grass. Outside of it, it will, for the most part, thrive only under the most favorable conditions. In the Northwest the su-

premacy of timothy has been threatened in recent years by brome-grass, and alfalfa is now invading the whole timothy region. In Montana, northern Utah, and southern Idaho, timothy thrives well on irrigated land, though it is not usually grown where alfalfa succeeds. In the mountain valleys of all these States, and of Washington, Oregon, and northern California, it is again the leading hay grass on cultivated lands.

The following notes from experiment station publications and agricultural papers in the border States indicate the position of timothy in these States :

South Dakota Bulletin 45.—A paying crop throughout the Big Stone Basin and the Sioux Valley; endures the cold and dry freezing of the Dakota winters, but suffers badly from the hot sun of July and August. Generally successful over the eastern part of the State. Does well also in some parts of the Black Hills region.

Kansas Bulletin 102.—Succeeds well in eastern Kansas, but is uncertain in other parts of the State.

Arkansas Bulletins 29 and 36.—Of little account, except on the best clay soils of northwest Arkansas and on the best bottom-lands of eastern Arkansas, but grown generally in northwestern part of State because of its reputation elsewhere.

Alabama Canebrake Station Bulletin 9.—Grew well during fall and winter, but could not stand warm weather that came in May. Not a pound of hay could be cut from the plat.

Southern Planter, January, 1903.—Makes but one crop in the South, and summer will kill it out. Better sow redtop and meadow-fescue.

North Carolina Bulletin 108.—Sown in fall, it gives a crop of hay in May or June, but frequently does not survive the heat of summer.

Tennessee Bulletin, Vol. IX., No. 2.—The best timothy lands in Tennessee are in the eastern valley, the central basin, and the northern and western counties of west Tennessee. Adapted only to rich, moist, alluvial soils. (This last statement applies to all the border States.)

Kentucky Bulletin 87.—Excellent on good loam soils. Will not thrive on light loam. Very little aftermath. Generally sown with clover. Usually grown in the Blue-Grass Region, in the mountainous counties of the east, and on the strong alluvial soils of the extreme western part of the State.

How different this from a Missouri Bulletin, and echoed in most parts of the timothy region proper: "The only hay grass grown to any extent in the State."

In these border States and beyond them timothy succeeds only on rich, moist, alluvial soil. Even in the timothy region it is particularly adapted to this class of soils, but by no means confined to them.

SEEDING

In the heart of the timothy region it is usual to sow timothy with wheat in the fall, adding clover in late winter or early spring. The usual amount of seed used is 8 to 12 quarts (12 to 18 lbs.) of timothy and about 8 lbs. of clover. The timothy-seed is usually placed in a special grass-seed compartment of the grain drill. Some farmers allow the timothy-seed to fall in

front of the drill hoes, so that it is covered by them; others allow the grass-seed to fall behind the hoes, leaving it to be covered by rain. It is generally recognized that the latter is not the best method of securing a stand of timothy, but from Illinois eastward it is fairly certain to result in a good catch. In years of light rainfall it sometimes happens that there is not enough moisture for both grain and grass, and the grass suffers. Sometimes also, when the grain is cut, a spell of hot, dry weather kills the tender grass, which has previously been shaded by the grain. This is particularly the case if the grain is allowed to stand until it is dead ripe, as at harvest-time the season of dry, hot weather is close at hand.

Even where wheat is not a very satisfactory crop, as on the rich, black prairie soils of northeastern Illinois, some farmers sow a little wheat, in order, as they say, to have a good place to sow timothy. On this soil timothy is not as popular as it once was, partly because wheat is less grown than formerly, and partly because the development of beef-raising has created a greater demand for pure clover hay and lessened the usefulness of timothy on the farm. Doubtless, also, the abundance of hay in the Middle West more than supplies the city demand, and a smaller proportion of the hay growers grow hay for the markets than is the case farther east. Since most of them use the hay on their own farms, and as they usually have a larger number of cattle than horses to feed, they grow more clover and less timothy than the farmers of sections farther east, where hay is largely grown for horses in the cities.

It is well known that when timothy is sown in the fall with grain it does not make a crop the next year. But it is not so well known, especially in the Middle West, that when timothy is sown in late summer or early fall without a nurse crop it makes the best crop of its life the next year. In this case clover should be sown at the same time as the timothy, but there are doubtless large areas in Missouri, Iowa, Illinois, and perhaps also in Minnesota and Wisconsin, where clover would winter-kill when sown in this manner. Since this method is so successful in the Eastern States it might be well for Western farmers to try it more extensively. Oat-stubble would be particularly adapted for this purpose, as the grass and clover could be sown after oats early enough to get a good start before winter. If the method proves satisfactory it would enable the timothy grower to dispense with wheat in the rotation, particularly where wheat is grown mainly to have a place in the rotation to sow timothy.

In New England, New York, and Pennsylvania three methods of starting timothy are in vogue. Many farmers use the method described above—namely, of seeding the timothy in the fall with wheat or rye, adding clover in early spring. Both East and West the time chosen for sowing clover in this manner is in very early spring, at a time when the ground is lightly frozen and cracked "honeycomb" fashion. The seed falls, or is blown, into these cracks, and is thus covered when the ground thaws. This is usually in late February or early March.

Another method, used extensively by the most progressive farmers, is to sow all the grass and clover

seed together in late summer or early fall (usually late in August) without a nurse crop. This gives an abundant harvest of hay the next year. On soils where there has been great difficulty in securing a catch of clover by the old method in recent years this method gives excellent results. How far west this practice would be successful the writer does not know, but it is certainly worth trying in Ohio and Indiana. Where this method prevails redtop and alsike are quite generally added to the mixture. The amount of alsike-seed used in such mixtures is usually only one or two pounds. The amount of redtop varies with different farmers, from a couple of pounds to half a bushel of seed in the chaff. These two grasses are quite generally used all over the East. The most successful farmer the writer has ever known uses the above method of seeding grass, his mixture containing all four of the grasses mentioned. He sows the last week in August, and cuts three times the next year.

The third method, sometimes met with in New England, is to sow all the grass-seed in the spring, either with or without grain. In this case no crop of hay is secured till the next year. It is not a plan to be recommended for general use where either of the others is feasible.

South of the timothy region proper early fall sowing, without a nurse crop, is by all means the best. In this section it is also well to add some other perennial grass, such as orchard-grass, meadow-fescue, or tall meadow oat-grass. These are better adapted to the region than timothy, and, except on the very best

soils, might replace it altogether. They are also better adapted to sowing with clover, since they mature at the same time that clover does. Spring sowing is particularly objectionable in the South, and the farther south the more undesirable it becomes. In the first place, spring-sown grass is likely to be taken by weeds, especially by crab-grass. It is also liable to be killed by the summer heat.

On the northwestern prairies the best practice is to prepare land in fall and sow grass and clover in spring without a nurse crop. There is usually not moisture enough for both grain and grass, while fall-sown grass would hardly stand the rigor of the first winter. The same is generally true on the irrigated lands of Wyoming and Montana. On the upland prairies of eastern Washington, eastern Oregon, and northern Idaho, spring sowing is necessary, for during the winter there are liable to occur periods of clear weather in which the ground freezes at night and thaws in daytime, a condition quickly fatal to young grass. But in this section the land cannot be prepared in autumn with safety for two reasons: first, the winter rains would wash it, for the country is quite rolling; secondly, the dry winds of early spring would quickly rob the bare soil of its moisture, while a covering of wheat-stubble prevents this. The best plan is to plow the land in early spring, harrow it down, and sow the seed at once. At low altitudes in this section, as around Walla Walla and Pendleton, fall sowing is successful. In western Washington, western Oregon, and northern California timothy is nearly always sown in the fall. On sandy land in that section clover may

be sown in either fall or spring, but on clay land it is always sown in spring.

Timothy sown alone or with mammoth clover yields only one cutting a season. When mixed with common red clover two crops a year are cut, the first consisting of both clover and timothy, the second of nearly pure clover.

In many localities, particularly where timothy hay is grown for market, it is customary to leave a meadow down for many years. In such cases the yield seldom exceeds a ton and a quarter a year after the first crop. This practice is hard on the soil, and cannot be considered high-class farming. Yet, if kept free from weeds, pastured very lightly, and frequently top-dressed with good manure or with a complete fertilizer, fairly good yields may be mantained for many years.

FEED VALUE OF TIMOTHY

The value of timothy hay for different kinds of stock depends on the stage at which it is cut. For cattle it should be cut just after it is through blooming. When the stamens of the timothy flower have just protruded from the glumes, it is popularly said to be in the first bloom. When the stamens have burst and shed their pollen, and hang limp and empty on their slender stalks, it is said to be in second bloom. This, or a day or two later, is the stage to cut it for cattle. During the next week or ten days, after reaching the second bloom, timothy rapidly changes in character and flavor. Horses eat it more readily if cut when the seed is about grown. It is also less washy

when cut at this late stage, an advantage for horses, but a disadvantage for cattle. The hay is richer when mixed with clover, but unless the clover is bright and green horsemen object to feeding it. Unfortunately, clover (the common red clover) ripens a week or more ahead of timothy, and is, therefore, liable to be more or less over-mature when the hay is cut.

In general timothy hay is better for horses than it is for cattle, though when cut early, and especially when mixed with clover, it is excellent feed for cattle that are supplied with plenty of protein in their grain feed. As already stated, it is the demand for horse feed in the cities that fixes the price of hay in this country. Hence timothy is the standard, and frequently almost the only hay on our markets. In only two cases known to the author does any other hay lead timothy in favor with the horsemen. These are the bluestem (*Agropyron occidentale*) of Montana and southeastern Colorado, and South Park hay (*Juncus balticus*) in Denver, Colorado. Brome-grass hay is perhaps the equal of timothy hay for horses, but it is as yet hardly known on the markets.

AS A PASTURE GRASS

As previously stated, timothy meadows are frequently converted into pastures at the end of the second year, and frequently also the slight aftermath is pastured where hay is cut. It does not stand grazing as well as many other grasses. Outside of the limits of the timothy region proper, as in the Dakotas, in Tennessee, etc., the best authorities advise against pasturing it at all.

YIELD OF SEED

The yield of all grass seeds is very variable. Three bushels of timothy-seed (a bushel weighs about 45 lbs.) is considered a low yield, five is fair, and eight is good. Yields of ten or twelve bushels are sometimes obtained. When sown for purposes of seed-growing four to six quarts of seed (six to nine pounds) only is used. The price of the seed varies considerably, but it is always so low that it costs less to seed an acre of timothy than of any other grass. This is probably one reason why American farmers grow timothy almost to the exclusion of other hay grasses.

VII

THE BLUE-GRASSES

KENTUCKY BLUE-GRASS (*Poa pratensis*)

"Ever smelt Kentucky grass,
Or heard about its blueness?
Seems as if the whole blamed world
Was bursting out with newness.

"Skies and folks alike all smiles—
Gracious! you are lucky
If you spend a day in June
Down in old Kentucky."

—ALFRED MUNSON.

BLUE-GRASS (June grass, Kentucky blue-grass), Fig. 18, is the standard pasture-grass of the country—at least, in those sections where tame pastures are mostly found. When the American farmer speaks of grass he usually means blue-grass. It is the one grass celebrated in song and story. In the Blue-Grass Region of northern Kentucky, and in many parts of Missouri, Iowa, Illinois, Indiana, and Ohio, blue-grass pastures are the pride of the thrifty farmer. Its palatability to all classes of stock, the evenness of the sod it forms, the beautiful color of its verdure, and its increasing productiveness with age, if properly handled, all conspire to make blue-grass the king of pasture-grasses.

It is in the Blue-Grass Region that fine horses and

FIG. 18—KENTUCKY BLUE-GRASS

beef-cattle attain their highest development in this country. Were it not for its habit of remaining dormant during the dry, warm months of summer, the length of time required to secure a good stand of it, and its comparatively low yield of forage, blue-grass would indeed leave nothing to be desired as a pasture-grass on soils to which it is suited. This is rather a formidable array of objections to bring against the "king of pasture grasses," but they are real, and the very general dependence on blue-grass for pastures leads many American farmers to the conclusion that they cannot afford to keep good land in pasture. This is particularly true in sections where the dairy industry is important. But in those portions of the country in which the production of beef is the leading feature of farming, blue-grass pastures occupy much of the most productive land; in fact, good pastures are indispensable to the economical production of first-class beef and in raising horses on a large scale. For this reason we find these two industries most highly developed in the sections where blue-grass is at its best.

Throughout the southern portion of its distribution this grass is called "blue-grass" or "Kentucky blue-grass." In Iowa and the central parts of Illinois, Indiana, and Ohio, the name "blue-grass" is generally used, while farther north it is generally known as "June grass."

The name "Kentucky blue-grass" originated from the fact that the grass first became prominent in that State. There are now sections of Iowa, Missouri, and Illinois in which blue-grass is nearly or quite as productive and as much prized as it is in the Blue-Grass

Region of Kentucky. According to Bulletin 19 of the Bureau of Plant Industry, United States Department of Agriculture, the principal centre for the commercial production of blue-grass seed is Bourbon, Fayette, and Clark counties, Kentucky, in the heart of the Blue-Grass Region. Considerable seed is harvested in the adjoining counties of Scott, Montgomery, Woodford, Franklin, and Jessamine. "Most of the seed is secured within a radius of twenty-five miles from the centre of a triangle formed by lines connecting the cities of Lexington, Paris, and Winchester." In recent years considerable blue-grass seed has been harvested in southern Iowa and northern Missouri. Small quantities are also harvested in other States.

Distribution.—Fig. 19 shows approximately the distribution of blue-grass in this country. By referring to Fig. 17, it will be seen that blue-grass agrees very closely with timothy in its distribution. These two grasses and red clover, which has nearly the same distribution, undoubtedly account for the high development of livestock farming in the northeastern quarter of the United States.

Each dot on the map shown in Fig. 19 represents a correspondent who, in answer to a circular letter, reported blue-grass as an important grass in his locality. The census returns give no clue to the area devoted to blue-grass. What little hay is cut from it is included in the "other tame grasses" of the census reports. The yield of blue-grass hay seldom exceeds half a ton per acre, except in very restricted localities on the north Pacific Coast, and it is therefore seldom cut for hay.

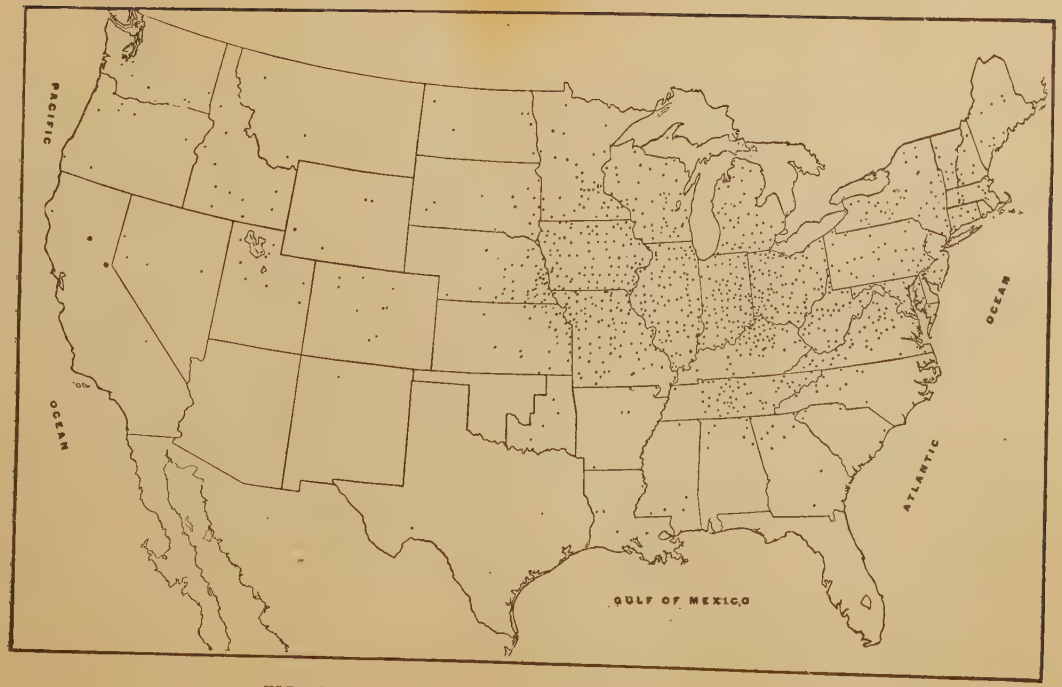

FIG. 19—DISTRIBUTION OF KENTUCKY BLUE-GRASS

The distribution of blue-grass south of the glacial drift is exceedingly interesting. In this region it is confined to the magnesian limestone soils of the geological area known as the Cambrian. A great tongue of this limestone soil extends southward from Cincinnati, Ohio, into northern Kentucky, a distance of about one hundred and ten miles, and is nearly one hundred miles broad. This constitutes the famous "Blue-Grass Region" of Kentucky. The geographical centre of this region is a point about twenty-two miles north of the City of Lexington, and it extends about twenty-five miles south of that city. It is in this region that most of the blue-grass seed of the country is harvested. From this a narrow strip extends into Tennessee, and there spreads out and occupies the "central basin" of that State. Blue-grass again appears in the mountain valleys of eastern Tennessee and western Virginia, where it is an important pasture-grass. It appears more sparingly in the hill country of the western Carolinas, northern Georgia, and northern Alabama. Some blue-grass is also grown on the black, sticky prairie soils of northeastern Mississippi. The Cambrian soils above referred to are the only southern soils that at all resemble those of the region north of the Ohio River, and it is only on them that the type of farming prevalent in the North is found in the South. Aside from the exceptions just noted, blue-grass is confined rather strictly to the glacial drift of the Northern States. Its very general distribution over the drift area is supposed to be due to the lime, magnesia, and, perhaps, potash in these soils. Climatic conditions are also more favorable to blue-grass in the

North, and it is not so particular as to soils in that region as it is in the South, where the long, hot summer season is fatal to it, except under the most favorable conditions. In the extreme southern portion of its range it is decidedly shade loving, and even as far north as Minnesota it luxuriates in the shade of open woodlands. The writer has seen large areas of blue-grass cut for hay in woodlands in the vicinity of Minneapolis. It makes excellent hay, but the yield is low.

BLUE-GRASS PASTURES

While blue-grass is more generally distributed over the northeastern portion of the United States than any other grass except timothy, it is only in comparatively limited areas that it is sufficiently productive to induce farmers to devote their best lands to it. Fine blue-grass pastures are common in the Blue-Grass Region of Kentucky, in central and northern Missouri, eastern Kansas, on alluvial soils in eastern Nebraska, in all of Iowa (except the northwestern portion), in Illinois, Indiana, and Ohio. Elsewhere they are less frequently seen, and much of the land occupied by blue-grass is so overgrown with weeds and brush, and so badly managed generally, as to be of little value. No grass equals it for pasture purposes in open woodlands and on rough, untillable land throughout its range, but on good arable land, where the ordinary crops can be grown, its usefulness is limited to comparatively small areas. Yet it is in just these areas that the best horses and cattle are found in this country.

In the northern portions of its range blue-grass furnishes most feed in spring and fall, remaining dormant

during the hottest portion of summer and being covered too deeply with snow in winter for stock to reach it. Farther south the dormant period of summer is more pronounced, but the slighter depth of snow makes it available as a winter feed, for which it is justly prized in the latitude of southern Iowa and south to the limits of its range. When winter pasture is desired it is wise to keep stock off blue-grass pastures in the fall.

One of the most valuable characteristics of blue-grass is its exceeding palatability to all kinds of stock. This is fully as important as its well-known nutritive quality. Stock eat it so readily as to render blue-grass pastures the most valuable adjunct to grain in the fattening process. It is becoming more and more the practice in the region where good blue-grass pastures are common to fatten cattle while at pasture. Gains are made more cheaply on such pastures than in any other manner. Without them beef production requires the most favorable conditions for success.

In most parts of the Blue-Grass Region it is customary to provide other green feed for stock in midsummer, for pastures are liable to be short at that season, especially if rainfall is scanty. Those who manage their pastures most judiciously prefer to let them rest during midsummer, even in seasons where there is good feed on them, so as to make them more productive late in the season.

It is well known that blue-grass is slow in starting on freshly seeded land. Many farmers never plow up a good blue-grass sod because of the difficulty of starting a new one and the great length of time required.

One of the best authorities on the subject in the Central West says it takes three years under the best conditions to get a good stand of blue-grass, and that it takes ten, fifteen, or twenty years to get a first-class blue-grass pasture. "The very best blue-grass pastures we have ever seen are on lands that have never been profaned by the plow." The same authority recommends that every two or three years a blue-grass pasture should be disked throughly and sown to a mixture of mammoth, red, and alsike clover. Pastures thus treated furnish feed during midsummer when blue-grass is ordinarily dormant.

The difficulty of starting blue-grass is increased by the fact that much of the seed on the market is of low germinating quality. It has been shown by the investigations of the United States Department of Agriculture that the cause of this is faulty methods of handling the seed during the harvest. Where large areas are to be harvested much of the seed is gathered too green. In curing it is customary to pile the freshly stripped seed in long, narrow ricks a foot and a half to three or four feet high. When heaped together thus the mass heats rapidly, and frequently the germinating power is thus completely destroyed. Temperatures of 148° F. have been observed in such ricks twenty hours after the seed was thus heaped, and only 3 per cent. of the seed retained its germinating power at that time. So general was this faulty method of curing blue-grass seed a few years ago, that seed laboratories considered a germination of 25 per cent. excellent. Even now 45 to 50 per cent. is the figure usually given as the standard for germinating

power of prime blue-grass seed. Yet in tests of properly cured seed 90 per cent. or more have germinated.

Poor seed undoubtedly accounts for many failures in attempting to start blue-grass pastures. Unless the germinating power of such seed is known, it is pure guess-work to determine the amount required to secure a stand. Ordinarily 25 or 30 lbs. of good, germinable seed is sufficient to seed an acre, but it is usually wise to use at least twice this much of the common run of seed on the markets. Seedsmen should be required by law to guarantee the germinating power of blue-grass seed, as well as other seeds. To do this it would be necessary to charge a higher price for the seed, but in the end it would be cheaper to the farmer. Under present conditions no seedsman, however desirous of furnishing only high-grade seeds, can afford to guarantee his wares, for he would be compelled to charge such prices that farmers generally would buy from his competitors inferior seeds at a price which appears to be cheaper, but which in reality is not so.

There is no universally recognized way of starting a blue-grass sod. This is partly owing to the numerous failures of all methods from bad seed. Some farmers in the Central West scatter the seed in cornfields in late summer or early fall. Others sow it with clover on wheat and timothy in early spring. Some prefer to sow on a light snow, while others sow at a time when the ground is lightly frozen and cracked, honeycomb fashion. On account of the length of time required to start a blue-grass pasture, it is quite common for the seed to be sown when a timothy and clover meadow is laid down. By the time the meadow has

been cut for hay two or three seasons there is usually a fair sod of blue-grass. These meadows are then converted into pastures, the timothy and clover gradually disappearing as the blue-grass sod becomes well established. After a few years' use as pasture such fields are usually plowed up for corn. The amount of plant food that accumulates in a well-managed pasture of this kind enables the farmer to secure one or more heavy crops of corn. After running such a field through the usual rotation of the locality, it is again set to grass in the manner above outlined. The practice just described is common in Kentucky, western Maryland, western Virginia, and in parts of all the other blue-grass States.

The value of blue-grass for pasture purposes in woodlands has already been mentioned. Much land that is now occupied by useless brush could be converted into valuable blue-grass pastures if rightly managed. To do this it is necessary to clear off the underbrush. If practicable the dead leaves should be burned. Blue-grass seed may then be scattered in late winter, and in a few years, if the underbrush and weeds are kept down, a fair stand of grass can be secured. Blue-grass pastures, to be made profitable, must be kept free from brush and weeds, and not stocked too heavily. The best methods of managing a pasture so as to secure the largest amount of feed are more fully discussed in the chapters on meadows and pastures.

In the New England States, where more or less permanent grass-lands occupy the greater portion of the tillable area, blue-grass is nearly always an important constituent of the herbage in meadows and pas-

tures. In the Northern Rocky Mountain States and in the Pacific Northwest many varieties of this species are found in the wild state, and they not infrequently appear among the grasses on the farms. It is not very highly prized in those regions because of its low yield of forage. Alfalfa, timothy, redtop, and orchard-grass all do well there, and yield much more feed. In a few limited areas in the State of Washington, especially in the western part, blue-grass is a troublesome weed. The variety found there grows very rank, and sends out formidable underground stems that make it difficult to eradicate.

Blue-grass is the universal lawn grass in the northern half of the United States, and it has no equal for this purpose where the soil is suitable and there is abundant water to keep it green during the summer. White clover is usually sown with it in lawns; indeed, it does better when mixed with white clover. These two plants are especially adapted to each other. The clover enriches the soil in nitrogen, greatly to the advantage of the grass.

CANADA BLUE-GRASS (*Poa compressa*)

This grass is of interest chiefly from the fact that its seed is sometimes used to adulterate the seed of Kentucky blue-grass. It has some value for pasture purposes on sandy soils in the far North. It also does well on poor clay soils where Kentucky blue-grass fails. It is also a fairly good lawn grass for dry regions, but must be kept closely mown. If allowed to grow up, its wiry stems, when cut back, leave a coarse, hard stubble, very undesirable in a lawn. In color it

is more nearly blue than any other grass. It does not grow so tall as Kentucky blue-grass, and may be distinguished from it by its flat stems and bluer color. In eastern Ontario and in western New York it is sometimes cut for hay. The hay is highly prized, being preferred by horsemen to timothy, but the small yield renders this grass of little importance for hay production.

TEXAS BLUE-GRASS (*Poa arachnifera*)

This is a grass that is more or less favorably known over most of the cotton-growing States. It produces a very beautiful sward which retains its deep green color at all seasons of the year. It is worthy of general attention in the South as a lawn grass. As is the case with Bermuda grass, it is difficult to start from seed, and it is usually started by planting small pieces of sod. The stems being upright, a sod can be separated into very small pieces, which should be set not over a foot apart each way, as it does not form a sod as quickly as Bermuda grass. This grass remains green winter and summer in the grass-garden of the Department of Agriculture at Washington. The difficulty of securing sod for starting Texas blue-grass is probably the chief reason why it is not more generally grown for lawn purposes in the South. It is gradually gaining ground, and may in time become important. It is rather too difficult to start to justify its general use as a pasture-grass.

VIII

THE MILLETS

THE term "millet" is applied in this country to four distinct groups of grasses. The most important of these is that to which common millet, Hungarian grass, and German millet belong. We may call these the foxtail millets, from the shape of the heads. These grasses are varieties of the botanical species *Chætochloa italica*. The next group consists of the varieties of the species *Panicum miliaceum*, known in this country as the broom-corn millets, from the fact that the head bears some resemblance to that of broom-corn. They have acquired considerable importance in the Northwestern Prairie States in recent years. The third group is usually known as Japanese millets. They belong to the species *Panicum crus-galli*, of which our common barn-yard grass is the best-known representative in this country. These millets are cultivated extensively in parts of Japan and China. Colorado grass (*Panicum texanum*) is sometimes called Texas millet. It constitutes the fourth group. It is not, strictly speaking, a cultivated grass, but considerable hay is made from volunteer growth of it in corn-fields in parts of Texas. The general discussion which follows applies only to the first two of the above groups, and more particularly to the foxtail millets.

Millet was one of the crops grown by our prehistoric ancestors. The seed is found in the débris

around the former habitations of the lake-dwellers of Europe. The date at which these people flourished is not known, but it was long before the dawn of history. Millet-seed seems to have constituted an important article of diet with them, as it does to-day in many parts of Europe and Asia. In America the first of the above classes of millet is grown exclusively for hay; the broom-corn millets are grown both for hay and for grain, but the grain is used here only for stock feed.

The distribution of millet hay production in the United States, according to the Census of 1900, is shown in Fig. 20. This map shows clearly that the millet region lies along the western border of the humid region, from Texas to the Canadian line. In Iowa, northern Missouri, northern Illinois, and southern Wisconsin the millet belt extends eastward into the humid region. Middle and eastern Tennessee constitute an island, so to speak. Millet is grown sparingly in nearly all parts of the country, but the acreage is too small in most sections to appear on the map, which was constructed by placing one dot in each county having 500 to 1,500 acres, two dots in counties having 1,500 to 2,500 acres, and so on.

There is apparently no reason why millet should be more largely grown in Wisconsin, Illinois, Kentucky, and Tennessee than in other parts of the timothy region. The large acreage in the belt of States from Texas to the Dakotas is readily understood. Millet is a short-season crop (particularly the variety known as common millet) which may be sown late in June and still produce a good crop of hay, even in the Dakotas. This region is more subject to crop failures

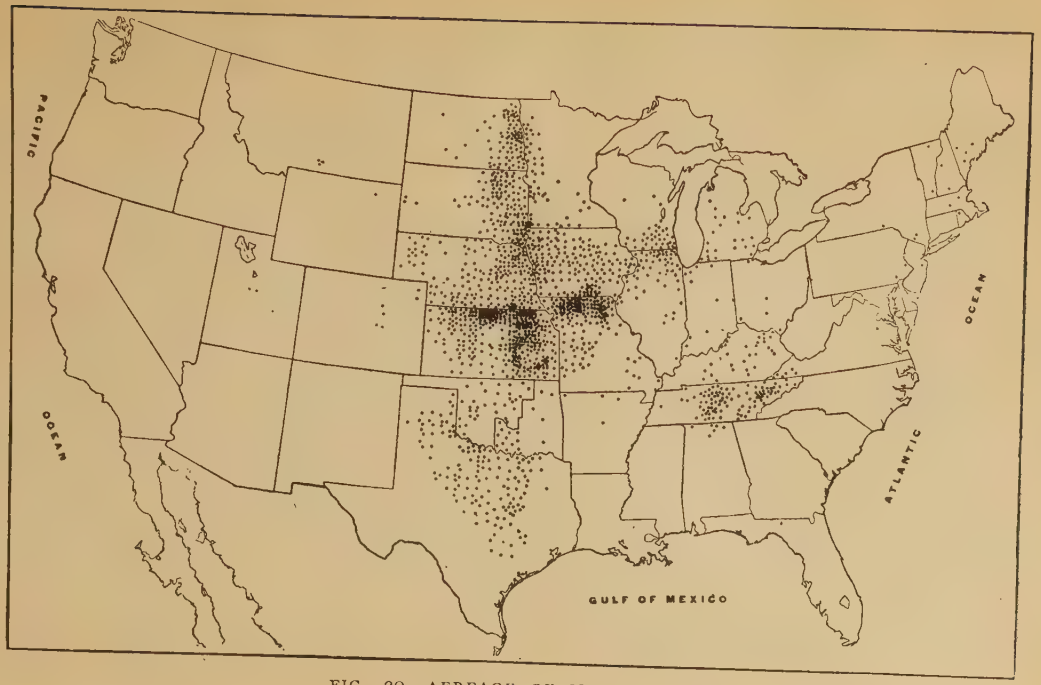

FIG. 20—AEREAGE OF MILLET HAY

from drouth than the States farther east, so that millet has come to be relied on there very largely. If a crop of winter wheat is winter-killed, or even a spring-planted crop, such as corn, fails because of unfavorable weather after planting, the land may be sown to millet after it is too late to plant other crops. Having learned the peculiarities of the crop, farmers grow it in that section very generally, even in years when it is not needed as a catch crop. From Illinois eastward it is more distinctly a catch crop, and is not very generally sown except in case of a shortage of other hay crops.

Millet probably has a larger field of usefulness in the Eastern States than has heretofore been accorded it. In most of these States it is customary to grow only one crop a year on a given field. But it is possible to grow a winter crop of rye hay and a summer crop of millet in most parts of the East, and both of these crops make good hay if properly handled. On farms where all the crops are fed, particularly on those which grow only the roughage and buy their grain, and therefore have an abundance of manure, and on which, in consequence, the soil does not particularly need the influence of leguminous crops, the above double-cropping system on a portion of the land is entirely rational. A few of the best farmers in the East practice this method on some fields. How far cow-peas will replace millet in this rôle cannot be stated. They are coming into prominence for this purpose in the North and East. In good seasons the cow-pea yields fine crops of hay, but millet has the advantage of being somewhat drouth-resistant. On farms not

well supplied with stable manure cow-peas should undoubtedly be grown in preference to millet—at least, in the East, where drouth is not likely to interfere with their growth. It is possible that the cow-pea may, in time, displace millet as a catch crop in the Eastern States, but we do not yet know enough about this crop in the North to state what its possibilities are in that section.

Millet has the reputation of being hard on the soil. Like sorghum, it is a heavy yielder, and makes large drafts on soil moisture and available plant food. It is also a coarse feeder, and for this reason it is particularly adapted to new land. In the West it is a favorite crop on newly broken prairie sod. It is also particularly adapted to newly cleared land in timbered sections. It likes a loose, porous soil, such as is found in new fields; on old land it prefers sandy soil to clay, because of its greater porosity. Yet it is not partial to poor land. A rich, porous soil, when put into fine tilth, is the ideal seed-bed for this crop. To get the best results the land should be thoroughly fined and not too much compacted before sowing millet-seed. Many farmers rebreak the land just before sowing this crop. Unlike wheat or alfalfa, it does not like a solid seed-bed. On a soil inclined to be heavy, after a millet crop is harvested care should be used not to plow the land when too dry, or it will break up cloddy. Millet is one of the best crops for taking the "new" out of the soil. If old soil is not well handled millet will take the life out of it. If the soil is abundantly supplied with barn-yard manure millet will not hurt it, and few crops will give a larger yield of good hay in

less time. Millet is considered a good crop to precede wheat, because it leaves a solid seed-bed. It is also one of the best crops for smothering weeds. Even Canada thistle can make little headway in a thrifty crop of millet. It is claimed by some that it will completely smother Canada thistle and quack-grass, but in order to do this the season must be very favorable to the millet crop and the soil must be put in fine condition.

On account of the rank growth of millet the hay is somewhat more difficult to cure than timothy. Fortunately it is not much injured by dew or rain, if allowed to dry properly before storing. No definite rules for curing the hay can be given, because the temperature and moisture content of the atmosphere have such a marked effect on the rate at which hay dries out in curing. It should lie in the swath longer than timothy, and when put up in cocks it should remain considerably longer than lighter kinds of hay. The writer has seen millet hay heat almost to the point of combustion from being put in the mow too early, though when stored it appeared as dry as hay is ordinarily when ready to put in bulk. Experience alone can determine the proper degree of dryness to insure safety from heating. On account of its solid stems it is heavier than other kinds of hay, volume for volume, and packs more solidly, thus causing it to shed rain better. It can, therefore, be left in the field to cure without great danger.

Millet is cut for hay at various stages. Some cut it just as the heads begin to appear ; others, when it is in bloom ; while still others cut when the seed is ripe. The season at which millet should be cut depends on

circumstances. Like most other crops, the length of time required to mature a crop of millet depends on the season. Since it is grown largely as a catch crop, it is sometimes necessary to cut it early to get the hay out of the way for another crop. It undoubtedly makes good hay when cut even before it begins to head, if properly cured, but the yield is larger and the quality just as good if cut in bloom. The quality of the hay deteriorates after the seed begins to form, and it is unwise to allow it to reach this stage unless a crop of seed is desired. In that case the seed should be allowed to get fully ripe. Hay from ripe millet is undesirable for two reasons: it is not so palatable nor so digestible as when cut earlier, and the hardened bristles become a source of annoyance and even danger to stock. Yet stock will eat millet straw from which the ripe seed has been threshed, and some farmers consider this straw very good feed.

Millet is well adapted for use as a green feed, and it is so used to some extent in the East, where the soiling system is coming to be generally practiced on dairy-farms. It is strong feed, and should be used with care, particularly when fed in the green state to horses. It is also suitable for use as temporary pasture. If hurdles are used, and care is taken not to graze too closely, it may be grazed over three or four times in a season.

The amount of millet seed required to sow an acre is about two pecks when sown for hay, and one peck when sown for seed. In some sections millet is sown in rows and cultivated, when grown for the seed. When thus sown a bushel of seed is sufficient for six or eight

acres. Seed grown in this manner is usually plumper and of better appearance than seed from thicker sowing. It is especially recommended to sow in rows and cultivate when growing millet on poor and weedy soil. New land is preferred for seed growing because of the absence of weeds. In the case of the broom-corn millets, the seed of which is considerably larger than that of the foxtail varieties, about three pecks of seed is used, either for hay or for seed production. While the seed of German millet is smaller than common millet and Hungarian grass-seed, that variety does not stool out so much as the other two just mentioned, and for this reason the larger number of seeds in a given volume gives no thicker stand of German millet than the smaller number contained in the same volume of common millet and Hungarian grass.

When grown for seed, millet may be cut with an ordinary twine-binder, and threshed the same as wheat, using, of course, finer riddles and less draft. The yield of seed is ordinarily from twenty to forty bushels per acre, though yields of eighty or more bushels have been obtained on good soil in favorable seasons. According to Professor Crozier, the average yield in twenty-seven counties in Iowa in the year 1889 was twenty-seven bushels. In the seed trade Hungarian grass-seed is bought and sold on a basis of 48 lbs. to the bushel, while 50 lbs. is considered a bushel of common and German millet. The legal weight of all three varieties is 50 lbs. per bushel in most of the States that have legislated on the subject.

Millet seed is excellent feed for all kinds of stock, but the price is usually too high to justify its use for

this purpose. On account of its small size and its hard covering, it should be ground, except for sheep and poultry. It is much used in mixtures for feeding birds, but it is considered more or less an adulterant in such mixtures, being inferior for this purpose to the seed of canary-grass.

VARIETIES

Foxtail Millets.—There are many varieties of this group of millets both in America and in Europe, but only three are of special importance in this country. These are: Common millet, Hungarian grass, and German millet. Of these the first-named matures in the shortest time, and is the predominant variety in the northern part of the millet-growing section. German millet is the latest of these three varieties, and is the standard in the southern portion of the country. Hungarian is intermediate in length of season, and predominates in the Eastern States. Although each variety thus has a section of country in which it leads all others in importance, they are all sown more or less in all sections. On account of its short season, common millet is best adapted for late sowing, especially in the North. It is also the best variety on poor soils, and resists drouth more than the others. On good soils, when it can be sown fairly early, German millet is the largest yielder. A typical form of foxtail millet is seen in Fig. 21.

Common millet was the first variety to gain prominence in this country. The date of its introduction is unknown, but it has been grown more or less for more than a century. It does not grow so large as

FIG. 21—TYPICAL FORM OF FOXTAIL MILLET

the other two varieties mentioned above, but the heads are larger and more open than those of Hungarian grass. Its seed is yellow, oval in outline, and is somewhat larger than that of Hungarian grass. It produces several stems from the same seed.

Hungarian grass has the smallest and most compact head of any of these three varieties. Its seed is shaped like those of common millet, but is mixed in color, part being yellow, part dark purple, and part intermediate between these two colors. Like common millet, it produces several stems from the same seed. It is intermediate in the length of season between the other two varieties, and is most popular in the Eastern States, where the seasons are short and where drouth is not so common as it is in the West. It makes large yields on good soil in moist seasons. It was distributed by the Patent Office about 1854, and immediately rose into prominence, particularly in the West. It has since gravitated eastward, because of its better adaptability to the climatic conditions prevailing there. It had previously been grown to some extent in this country under a different name.

German millet is a late-maturing variety having large, lax, nodding heads. Ordinarily it produces only one stalk to the seed, but these stalks grow taller and coarser than those of either of the other varieties. It is a large yielder, and is particularly popular in the Central and Southern States, where its long season is no disadvantage. It may be sown as late in the South as common millet in the North. It sometimes matures when sown as late as the first of July, even in the Central States. It is more drouth-resistant than

Hungarian grass, and is deservedly popular in Texas, Oklahoma, and Kansas. A great deal of the seed of German millet is grown in Tennessee, and Tennessee-grown seed has a very high reputation in the markets. The seed of this variety is yellow, and is considerably smaller than that of common millet. In shape the Southern-grown seed is round, but when taken North and sown the seed produced there assumes the oval shape of common millet seed. For this reason there has been considerable confusion among Northern seedsmen concerning the identity of these two varieties. Northern-grown millet seed is somewhat earlier than the Southern grown, but not nearly so early as common millet. German millet came into prominence about 1875.

The variety known as Golden Wonder has been grown quite generally during the past few years. It originated in Minnesota in 1884. It resembles German millet more closely than it does either of the other two prominent varieties, but is not so drouth-resistant. It is noted for the large size of its heads. It is a late variety, resembling German millet in this respect, as well as in its tendency to produce only one stem from each seed.

Broom-corn Millets.—Of the numerous varieties of this group of grasses, only a few have been tried on an extensive scale in this country. They differ from the foxtail millets in many important particulars. The stems are much larger, not so tall, and the head, as seen in Fig. 22, is not cylindrical. The seed is also much larger and of a different shape. Most of the varieties introduced into this country are much earlier

FIG. 22—BROOM-CORN MILLET

than the earliest of the foxtail millets; hence, they can be sown later. In fact, the millets generally should be sown later than most other crops, as the seed does not germinate readily till the soil is thoroughly warm. Because of their very short season, the broom-corn millets are especially adapted to the Far North. They are also more drouth-resistant than the foxtail millets. In recent years, at least, one variety has gained prominence in the Dakotas and adjacent States under the name "Hog Millet." Red Lump is another promising variety introduced by the Department of Agriculture a few years ago. Another good variety has more recently been distributed by the Department under its Russian name of "Proso." These varieties do not yield a large amount of forage, and they are not much grown for hay, but they yield a great abundance of seed, which is valuable for feed. Their worst fault is their tendency to scatter the seed. The top of the panicle ripens first, and the seed from this portion frequently falls out before the lower part of the head is ripe. When grown for poultry it is not necessary to harvest the seed if the field is near enough to the farmstead for the poultry to range on it.

JAPANESE MILLETS.—These are varieties of the species *Panicum crus-galli*. The best-known representative of the species is the barn-yard grass (Fig. 23), a common weed on moist, rich soils in every section of the country. In Arizona and southern California certain Indian tribes are said to make use of the seed of this grass for food. In parts of the West and South volunteer growths of barn-yard grass are frequently cut for hay. It yields a large amount of coarse

FIG. 23—BARN-YARD GRASS

hay, which is readily eaten by stock. This weed is evidently worthy of more attention as a fodder-plant than it has heretofore received, particularly for moist soils in regions where timothy does not thrive. It is strictly an annual, and is therefore not adapted to permanent meadows. It has been known to yield four tons of very good hay per acre on land where its seed was scattered by floods in the river-bottoms of northern Louisiana. A variety of this grass was exploited recently under the name "Billion-dollar grass." The sphere of its usefulness seems to be confined to wet meadows in the Far West and in the South.

During the past few years several varieties of this group have been introduced into this country from Japan, and have been tested by many of the experiment stations, particularly in the West. Some of them possess considerable merit, but none of them are as yet widely cultivated. In Japan and parts of China, especially in sections where rice does not thrive, these millets are important crops. They have been called Japanese millets in this country because the principal varieties were introduced from Japan.

Texas Millet (*Panicum texanum*).—This grass is a common weed on rich river-bottom lands in central Texas. The name most commonly used for it in that section is Colorado grass, since it occurs abundantly in the vicinity of the Colorado River in Texas. It is also sometimes called Austin grass, having spread down the Colorado River from Austin some years ago. Its habits are exactly like those of crab-grass. It comes up in corn-fields after the corn is laid by. It seeds abundantly, and the seed falls off very easily when

ripe. It therefore reseeds the land, and does not need to be sown. Its seed habits are such, in fact, that it can hardly be handled as a domesticated grass, for it is impracticable to harvest the seed. On account of its large yield of most excellent hay it is not generally considered a pest. The continuous cultivation of cotton-fields prevents it from bothering in them. When corn-lands have once become seeded to it a good crop of hay can be secured late in summer every year after the corn is harvested. Not infrequently a field, when well seeded to Colorado grass, is left untouched till late in May. It is then plowed and harrowed, and the grass allowed to grow, making a fine crop of hay. It is very leafy, the large, flat leaves resembling those of the foxtail millets. Like them, it is hard to cure for hay, but when well cured it is said to make hay of superior quality. This grass has been tried very generally over the South, but has gained little headway except where it has spread as a weed. By recognizing its essentially weedy character, and handling it accordingly, it may be made a valuable adjunct to the hay-producing plants on rich alluvial soils in the extreme South. On suitable soils it easily displaces crab-grass, but on light, dry soils it cannot cope with this less useful and weedy grass.

FEEDING VALUE OF MILLET HAY

It is universally agreed that millet hay is highly nutritious, and that it is eaten by all classes of stock as readily as any other hay generally grown in this country; in fact, many feeders state that stock prefer it to timothy. For the past half century it has been

grown and fed extensively over nearly the entire country. As far as chemical composition is concerned it has a slight advantage over timothy, as shown by the following figures, giving the averages for all published analyses in the United States up to 1890 : *

DRY MATTER	*Ash*	*Protein*	*Fibre*	*Nitrogen Free Extract*	*Fat*
Timothy	5.1	6.8	33.5	51.7	2.9
Hungarian grass	6.5	8.1	30.0	53.1	2.3

The slight difference in the content of fat is immaterial, and is counterbalanced by the excess of nitrogen free extract in the Hungarian grass. The latter contains considerably more protein and less fibre, both of which are advantageous.

The productiveness of millet, its palatability, and the nutritious quality of the hay would apparently justify the popularity which this crop has had at various times since its introduction in America. In the year 1885, according to Professor Crozier, the acreage of millet exceeded that of timothy in the State of Iowa. It has, however, a number of objectionable features, on account of which the area cultivated has fluctuated a great deal. It is coarse in texture, particularly when seeded thinly, and there is more or less prejudice against coarse grasses, though this matter is of no real significance if the grass is both nutritious and palatable. The hair-like bristles in the seed head

* Bulletin 11, Office Experiment Stations, United States Department of Agriculture.

are also objectionable. If the hay is cut over-ripe these bristles are apt to injure the mouths of stock. Cases have also been reported in which the bristles have formed hair balls in cows' stomachs, causing inflammation and resulting fatally.

We have already called attention to the impossibility, in actual practice, of cutting hay at just the right season; if delay in harvesting results in the development of decidedly objectionable characters in a hay plant, such characters are certain to limit the usefulness of the crop, for it will occasionally be necessary to cut over-ripe hay. The variation in coarseness, due to difference in thickness of the stand, is also a matter of some importance. Timothy, even when the stand is thin, does not grow much coarser stems than when the stand is normal. Millet, on the other hand, grows very large, coarse stems when for any reason a poor stand is secured. Even when plenty of seed is used the stand may be poor because of unfavorable soil conditions at seeding-time. This lack of uniformity in the character of growth of millet prejudices many against it.

The fact that millet is an annual may be either an advantage or a disadvantage, according to circumstances. It is probably true that millet would occupy a much more important place in our agriculture if it were perennial. The American farmer likes a grass that can be kept in a meadow for several years with no attention except to cut it for hay. At the same time, a productive, short-season annual is exceedingly useful for sowing when other crops fail; it is for this latter purpose that millet is most largely used. In some

seasons much more of it is needed for this purpose than in others, and this accounts, in part, for the fluctuations in the area of millet grown from year to year. Common millet and Hungarian grass at least may be sown at the North after it is too late to replant corn or other standard forage crops, and yet make a good crop of hay in time for a succeeding crop of winter grain. The only crop which rivals millet in this respect is the cow-pea, a crop not yet widely known in the Northern States, but which is gradually working its way northward. Millet possesses a distinct advantage over cow-peas for occupying this niche, particularly in the Northwest, because of its greater productiveness in dry seasons.

One other fact connected with the value of millet hay remains to be stated. Although it has been fed freely to all kinds of stock on thousands of farms for a quarter of a century with nothing but favorable results, there have always been persistent rumors that it may be injurious to horses. In some localities a peculiar ailment to horses has been called "millet disease," from the belief that it is caused by feeding millet hay. Like sorghum poisoning, this ailment is most commonly met with along the western border of the humid region, but this may be due to the fact that millet culture is much more general in that section than elsewhere (see Fig. 20). The symptoms of the disease are disturbances of the kidneys, causing increase in the flow of urine and lameness of the joints. Prof. T. D. Hinebauch, of the North Dakota station, in Bulletin 26 of that station, reports some interesting results in experiments inaugurated to test this point.

He fed several horses no other hay than millet for several weeks. Most of the horses showed no evil effect, but one in particular exhibited all the symptoms of "millet disease." Referring to the results of exclusive millet feeding, he says: "It produces an increased action of the kidneys, and causes lameness and swelling of the joints. It causes an infusion of blood into the joints and destroys the texture of the bone, rendering it soft and less tenacious, so that the ligaments and muscles are easily torn loose." Professor Ladd, of the same station, later isolated a glucoside from millet hay extract that produced these characteristic symptoms in small mammals to which it was given.

Some horses are evidently more subject to this disorder than others; most of them seem to be exempt. But that millet is occasionally the cause of such troubles is tolerably certain. Horses seem to be the only farm animals that ever suffer from this cause. Cases exhibiting the above symptoms were not uncommon among farm horses in southwest Missouri some twenty-five years ago, and millet was grown there to a considerable extent at that time. They were not then attributed to millet feeding, but it is probable, in the light of subsequent investigations, that this was the cause.

In Professor Hinebauch's experiments the symptoms of disease disappeared when other hay was substituted. It is generally believed that millet can be fed to horses with perfect safety if fed alternately with other hay. In by far the larger number of cases it can be fed without other hay and not produce any unfavorable effects. For sheep and cattle there seems to

be no question of the value of millet hay. In seasons when other hay is scarce it sometimes becomes necessary to feed horses on millet only. In such cases it is well to be on the lookout for millet disease, and change the feed of such horses as show the symptoms above described.

IX

TWO PROMINENT SOUTHERN GRASSES

BERMUDA GRASS (*Cynodon dactylon*)

THIS grass, known in the Southern States as Bermuda (universally pronounced "Bermooda"), in India as "doob," and in the British West Indies as "scutch-grass" (Fig. 24), is distributed throughout tropical and subtropical regions of both hemispheres. It is the great pasture-grass of subtropical and warm temperate regions throughout the world. (The localities where Bermuda grass is important are indicated in Fig. 25.)

So far as known, the following incident was the first introduction of this grass into the United States. Mr. James A. Bethune, of Washington, D. C., states that during the war of 1812 Mr. John G. Winter, a merchant of Greensboro, Georgia, compelled by the blockade of the Atlantic seaports to bring his merchandise in through St. Mary's, on the Georgia-Florida line, on one occasion threw into the street in front of his store some grass in which a shipment of crockery had been packed. The late Gen. James N. Bethune, then a lad of nine or ten years of age, living in Greensboro, picked up a sprig of the curious-looking grass and carried it to his mother. Good grasses being much needed in that section at that time, the sprig was care-

FIG. 24—BERMUDA GRASS

fully planted in the Bethune garden. From this it soon spread to the streets of the village. The embargo act is therefore probably responsible for the introduction of Bermuda grass into this country by making it necessary to secure foreign merchandise through the West Indies. There is no evidence to show that it came from the Bermuda Islands.

This grass has now spread northward to Maryland and westward to the Pacific Coast, and is nearly as common throughout the South as blue-grass is in the North. It is, in many respects, the Southern counterpart of blue-grass, and is, beyond question, the best pasture-grass in the South, and one of the best in the world. Like blue-grass, it is also the universal lawn grass of the section over which it has spread. It is distinctly a Southern grass, and revels in the hottest parts of the long Southern summer. Even in the extreme South it is not a shade-loving plant, but prefers the direct rays of the sun. It is not an uncommon thing to see Bermuda grass lawns with spots on the shady side of trees and shrubbery in which the ground is bare or occupied with more shade-loving plants, such as white clover.

Unlike blue-grass, Bermuda grass looks brown and dead during the winter season, and does not begin to "green out" till rather late in spring. In the latitude of Washington City it does not begin to throw out green leaves till May. Its color is a light green, not nearly so attractive as the richer green of blue-grass. For these two reasons it is not an ideal lawn grass. Nevertheless, a well-kept Bermuda lawn in the Southern States is decidedly beautiful during summer.

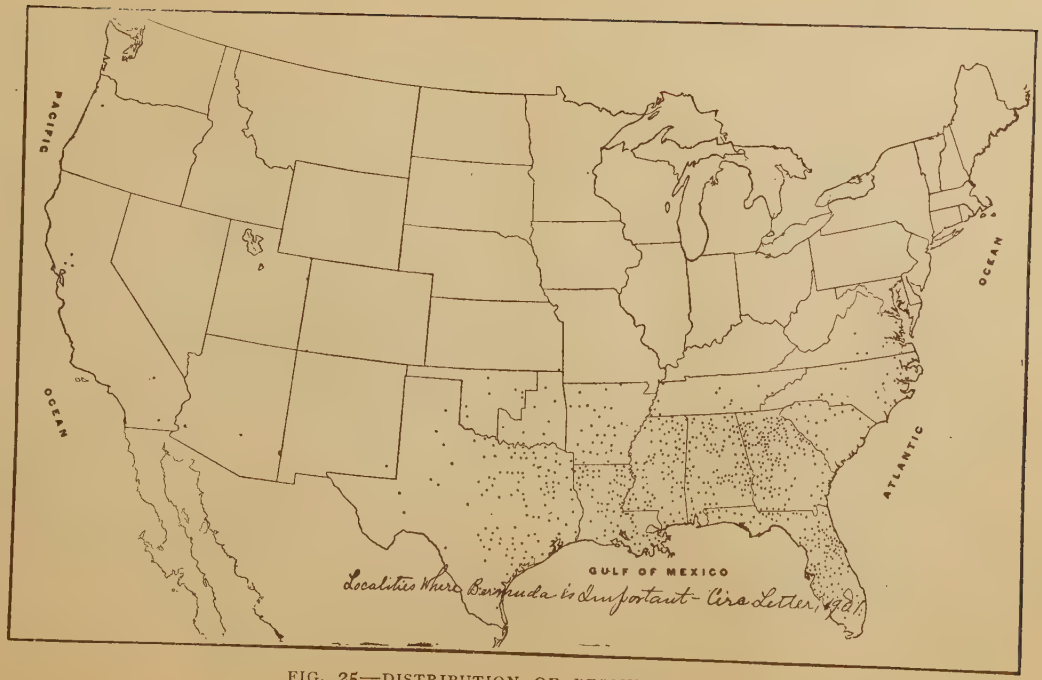

FIG. 25—DISTRIBUTION OF BERMUDA GRASS

(A plat of Bermuda grass in the grass-garden at Washington, D. C., is shown in Fig. 26.)

There is probably no other grass that bears pasturing better, or yields more herbage in the form of pasture, than Bermuda grass in sections where it is at its best. Unlike its counterpart in the North, it does not become dormant during the summer, but continues

FIG. 26—PLAT OF BERMUDA GRASS IN GRASS-GARDEN AT WASHINGTON, D. C.

its vigorous growth during the hottest weather. It also withstands drouth to a marked degree, but is not equal to the exceedingly dry climate of western Texas, New Mexico, Arizona, and southern California unless irrigated. Yet it remains green during protracted summer drouths of central Texas and States to the eastward. The quality of its herbage is probably not quite equal to that of blue-grass. Stock-raising is not yet sufficiently developed in the Bermuda grass region to justify a final judgment on this point. The best Bermuda pastures easily support two head of cattle per acre from April till late in October; not infrequently three head per acre are grazed on it during

early summer. On the experiment station farm at Baton Rouge, Louisiana, thirty head of cattle of all ages were kept on seventeen acres of Bermuda pasture, with no other feed, from March 25 to November 1. In addition to this, sixteen steers were kept on the same land for a few weeks when the growth was most vigorous. Professor Killebrew, of Tennessee, states that an acre of good Bermuda pasture will keep ten sheep in good condition for eight months in the year. This, of course, is possible only on the best alluvial soils in the warmer parts of the South.

For best results it should be grazed systematically —*i.e.*, the pasture subdivided, and the stock turned into one inclosure and allowed to graze it closely, and then removed to the next inclosure. They should then be returned to the first lot before the grass becomes tough and wiry.. (Bermuda grass is called wire-grass in many parts of the South because of the wiry nature of the fully matured stems.) If the stock is turned into a single large field, a good deal of the grass becomes so wiry by midsummer that they will not eat it readily.

On poor uplands Bermuda grass yields as little as blue-grass does in similar situations. In moist climates it will grow on nearly pure sand, while it also thrives on low moist lands, and is hardly injured by prolonged overflow. It is decidedly the best sand-binder and bank-holder in the South. It is the best of all grasses for covering washed hillsides. It will not thrive, however, on waste lands unless they are kept free from briers, sedge, and all tall-growing plants that would tend to shade it. On good alluvial soils it grows large enough to cut for hay, and fur-

nishes two or more cuttings, frequently amounting to four tons of hay a year. Its hay is of excellent quality, fully equal to timothy, though the amount of Bermuda hay on the markets is so small that it is not a factor in the hay markets of the South except in a few localities.

Like most dense, sod-forming grasses, Bermuda grass does best if broken up and harrowed down smooth every few years. This is particularly the case when hay is wanted. The hay, being light, is easily and quickly cured. In fair weather it may be cut, teddered an hour or two later, raked into windrows, and cocked up in one day. The hay should be allowed to dry out well before baling or stacking. If it is to be baled, it is a good practice in the South, where rain is liable to come at any season, to let the cocks stand a day or two in the field, then haul them to a shed, where the hay may remain a couple of weeks to cure completely before baling. The hay should always be cut before the stems become hard. Some advocate cutting three or four times a year, or every time it gets large enough.

It is not surprising that a grass so tenacious of life as Bermuda grass should be regarded in many places as a bad weed. In sections where a single crop system prevails, as is the case over most of the cotton-growing region and in the sugar-cane region of southeastern Louisiana, it is a much-dreaded pest. In recent years it has spread to the irrigated sections of the Southwest, where it has become a serious nuisance. It covers the banks of irrigating ditches, and from them invades fields of alfalfa and other crops. It is the one grass of the South that alfalfa cannot endure. Crab-grass can

be dragged out with a harrow; Johnson grass succumbs to the ordinary treatment of alfalfa fields. But when Bermuda grass gets a start it cannot be eradicated without destroying the alfalfa. The land must be entirely freed from Bermuda before seeding to alfalfa, or failure is certain. These are serious charges against this great pasture-grass. Yet, except in Florida, southern Arizona, and southern California, Bermuda grass seldom produces seed, and it is therefore comparatively easy to keep it out of fields where it is not wanted. Where it produces seed abundantly it runs riot everywhere and cannot be controlled. In the three localities named above it usually produces abundant seed, and is there the worst pest known. Under no circumstances should it be introduced upon a farm in latitudes where it produces seed.

While Bermuda grass is tenacious of life, it does not produce a great abundance of deep underground stems, as Johnson grass does. It spreads by long, creeping stems, which remain at or near the surface of the ground. It can be completely killed at one operation by plowing about one and one-half to two inches deep with a good, sharp turning-plow during dry, hot weather in summer, or just before a cold snap in winter. In the one case the stems are killed by drying, in the other by freezing.

It has already been stated that Bermuda grass does not stand shading well. It is, therefore, possible to smother it out by rank-growing crops. On this point Professor Dodson, of the Louisiana Experiment Station, says: "By breaking the sod shallow in December, and following with a crop that produces dense shade, such

as cow-peas or velvet beans, Bermuda grass can be exterminated in a single season." A very good system to pursue for this purpose on a stock-farm is to sow oats in the fall, harvest them for hay in the spring, and then seed thickly to cow-peas or velvet beans. South of Tennessee and Arkansas there is plenty of time for two crops of cow-peas in summer. This system continued for two seasons on land that is properly manured usually eradicates the grass completely, and gives two or three good crops of hay a year. One season of such treatment is frequently sufficient. Sorghum and millet are also good summer crops to use in getting rid of Bermuda grass. For this purpose sorghum should be sown thick—say, two bushels of seed to the acre. Bermuda grass, being of low growth, is completely shaded out by these taller, dense-growing crops. On good land in the South, oats yield two to two and a half tons, and sorghum six to ten tons, of excellent hay per acre. Killing Bermuda grass ought, therefore, to be a profitable pastime on Southern farms where hay is needed.

From what has been said it is clear that Bermuda grass is not seriously to be dreaded on a farm devoted to a rational system of crop rotation. Some of the best farmers the writer has ever known in the South make constant use of Bermuda grass for pasture on the rougher portions of the farm, and are never bothered with it in the slightest degree on the cultivated fields. Since it produces no seed, except in the extreme South, there is no danger that stock will scatter it in their droppings. Where it does not produce seed there is little difficulty in controlling it, and there is no ques-

tion that it is the best and most available pasture-grass in the cotton region.

There is a distinct variety of this grass in Florida, known as St. Lucie grass, that possesses many advantages over Bermuda grass. It grows larger, does not produce seed even in Florida, and remains green throughout the year. Its trailing stems form a dense mat that can be lifted up like a carpet, and are strictly above the ground. It is much preferred to Bermuda grass in Florida because it yields more herbage and is easily controlled. St. Lucie grass has not been given the attention in most parts of the South which it seems to merit. It is not known how far north it will thrive. It lived through the severe winter of 1903–04 in the grass-garden of the Department of Agriculture in Washington, D.C., and probably has nearly as wide a sphere of usefulness as Bermuda grass itself. It would probably be less difficult to eradicate than Bermuda grass, and would be likely to furnish as much or more feed. W. H. Haskel, of Florida, in a letter to the Department of Agriculture, speaking of the relative merits of these two grasses, says:

"St. Lucie grass is so superior to Bermuda grass that it seems to me to deserve special mention. Bermuda grass, in the agricultural section of Florida, is considered an unmitigated nuisance, because of the impossibility of exterminating it. Another disadvantage in it as a lawn grass, even here in a subtropical region, is that it becomes dormant and brown during winter, just when we want a lawn grass to look best. It is not nearly so rapid a grower for pastures as St. Lucie grass. Now the opposite of all

these adverse qualities is possessed by the St. Lucie. If a change in the field is desired, St. Lucie grass is as easily killed out as crab-grass. It grows the year around, except when temporarily set back by a freeze. Then, if burned off or cut off, in two weeks it comes out green as ever.'' It would probably not remain green in winter as far north as central Alabama, but its other advantages make it worth trying both for lawn and as a pasture grass over the whole South.

The price of Bermuda grass seed runs ordinarily from 75 cents to $1.00 per pound, sometimes more. The supply comes almost entirely from Australia. It is one of the most unreliable seeds on the market, a fact probably due to improper methods of handling in curing and shipping. Even the best of Bermuda seed is very uncertain. Some time ago the writer went over all the reports received by the Department of Agriculture from farmers to whom this seed had been sent for several years past. Out of a dozen men reporting on seed from the same lot three or four would report a perfect stand, the others total failures. For this seed to germinate, the conditions must be exactly ideal: the soil prepared with the greatest care, amply supplied with moisture, be thoroughly warm, and the weather must be favorable for a considerable period after sowing. On account of the uncertainty of this method of securing a stand of Bermuda grass the seed is seldom sown.

The more usual, and by far the most reliable, way is to plant small pieces of sod. The methods of doing this are nearly as numerous as there are Bermuda grass growers. Usually a piece of sod is plowed as

shallow as may be with a turning-plow. It is then gathered up, shaken as free from earth as possible, and then cut or torn into small pieces. A single piece of stem with a joint in it will start a new growth if buried shallow in moist soil. For lawns the pieces of sod are usually set by hand about a foot apart each way in a carefully prepared soil. This is usually done in the spring, though it can be done at almost any season except when there is danger of freezing weather. For pastures much less careful methods will suffice. A very good plan is to scatter the pieces of sod in standing corn, and cover them at the last cultivation. When the soil is wet a barefooted boy, with a sack or basket of sod, may drop the pieces of sod and press them into the soil with his foot.

Another good plan is to scatter pieces of sod in every alternate furrow as the land is plowed. The thicker they are placed the sooner a stand is secured ; but if dropped every eighteen inches or two feet, and covered from two to four inches deep, the grass will completely cover the land next season. Another plan frequently employed is to plow and harrow the land, lay off furrows as for planting corn by hand, but with the furrows only about two feet apart; drop the sods a foot or two apart in these furrows, and cover by means of a harrow or drag. In regions where it is safe to sow oats in spring the sod may be freed from soil and run through a feed-cutter. The fragments may then be broadcasted along with the oats and harrowed in. The grass will make little headway till the oats are cut, but will form a good sod by the next spring.

Many attempts have been made to find some winter-

growing plant that may be grown with Bermuda grass, so as to furnish pasture the year around, but without much show of success. Hairy vetch, if carefully handled, has some value for this purpose, but if eaten too close in spring it fails to reseed itself and thus disappears. On the other hand, if allowed to grow too rank in spring, it kills out the grass and makes the pasture patchy. Bur clover has been recommended for this purpose, but the same objections hold in this case as those just stated for hairy vetch. It is also not readily eaten by stock. Texas blue-grass has also been tried as a winter companion for Bermuda grass, but not on a scale sufficient to give positive results. A few farmers report favorable results with it. By plowing Bermuda sod in autumn it is probable that a crop of fall-sown oats could be grown for hay and leave good pasture the next summer, though this suggestion rests rather on theory than on experience.

JOHNSON GRASS (*Sorghum halapense*)

In South Carolina this grass (Fig. 27) is generally known as Means grass, while it is frequently but erroneously called "Guinea grass" in Alabama and other sections of the South. It is unquestionably the worst weed in the South. At the same time, it yields two to three crops of good hay a year. Those who are not acquainted with Johnson grass are often inclined to think that a weed that yields such crops of good feed is a good one to have on a farm, and this would, in fact, be the case if only the one crop were desired. There are, however, very few farmers who want to grow nothing else. Those whose farms are free from

FIG. 27—JOHNSON GRASS

Johnson grass very wisely refuse to feed the hay, nor will they buy horses or other stock from stables where it is fed. For these reasons there is not an extensive market for the hay.

As to the feeding value of Johnson grass hay, it may be stated that all kinds of stock eat it greedily. Horses prefer it to timothy, and it is fully as nutritious as the latter. For cattle, idle horses, and horses at ordinary work, the only possible objection to the hay is the danger of spreading the seed of it in the droppings. It is not a satisfactory feed for livery-stable horses, being too laxative. It might seem that the danger of spreading Johnson grass could be averted by cutting the hay before the seed is ripe, but such is not the case. In the first place, it is not always possible to cut hay at the right time, because of unfavorable weather, pressure of other work, etc. Again, the seeds of grasses are so inconspicuous that it is not always easy for the farmer to tell just when the grass must be cut to avoid getting seed in the hay. Another difficulty arises from the fact that the first crop of the season is usually very irregular in coming to maturity, and ripe seed is found on some plants before others head out. Then, on a Johnson grass infested farm, there is always more or less of it scattered along fence-rows, ditches, and other waste ground, and the seed scatters from these stray patches. In the language of an Erath County, Texas, farmer, "Johnson grass would be a good thing on a place if you could keep it where you want it."

The farmers of the South generally regard Johnson grass as an unmitigated evil, though one finds here

and there a farmer who speaks a good word for it. In some States there are laws against the sale of the seed. While there is no question as to the value of the grass for hay production, it is doubtful whether a farmer is justified in introducing Johnson grass even on a stock-farm in the South. What position it would hold in the agriculture of the South should livestock farming become general there it is difficult to say. If it should prove to be possible, by selection or crossing, to secure a variety with less formidable rootstocks, so that it could be killed as easily as blue-grass is in the North, it would become the great hay grass of the South.

The difficulty in eradicating Johnson grass is due to the fact that it produces long, underground stems which possess great vitality. It is well-nigh impossible to free the soil completely from these "roots," as they are called. They are not roots at all, but are underground stems, having joints, with a rudimentary leaf and a bud at each joint. A small piece of rootstock having a bud on it will develop a new plant if given half a chance. By plowing the land in the fall and harrowing out the major portion of the rootstocks it is possible to grow an excellent crop of corn or cotton the next year practically free from Johnson grass; but by another year the pieces of rootstock left in the ground by the harrow re-establish the grass sufficiently to make it troublesome. The third year it is usually as bad as ever.

The difficulty in dealing with this weed is greatly increased by the implements used for tillage on many Southern farms. To check the grass effectively a good two-horse turning-plow is absolutely necessary, an im-

plement not found on many small farms. In plowing it is necessary to cut and turn over every inch of the land. By doing this it is entirely possible to plow a Johnson grass meadow in spring, harrow out the rootstocks, and make a good cultivated crop the same year; but it requires careful work, and a great deal of it, to do so. The grass may be entirely eradicated in a single season if the farmer can spare the land and afford the necessary labor. The best way to do this is to plow the land with a turning-plow in the fall, selecting a time when the soil is mellow. Harrow out as many rootstocks as possible and remove them from the field. Then sow some winter grain, such as oats, barley, or rye. Wheat is too late in maturing. The grain should be cut for hay in the spring, and the land plowed again immediately and thoroughly harrowed, as in the fall previous. Then every time the most forward bunches of grass reach four to six inches in hight, run over the land with a heel-scrape or any other implement that shaves off the surface of the soil. To be effective this shaving process must be so thorough that every sprig of grass is cut. If this is kept up till October every vestige of Johnson grass will be destroyed. It may come again from seed the next year, but the seedling plants may be killed, like any other weed, by thorough cultivation. Care should be taken not to let any of them get large enough to send out rootstocks before destroying them. Some badly infested farms have been freed from this pest by the above method.

The usual practice is to take one field at a time for this treatment, taking several years to extend the work of eradication over the whole farm. With a rational

system of crop rotation, and the thorough working of the soil common in the north of England and in many parts of this country, Johnson grass would not be a pest, but a valuable adjunct to the list of farm crops. The climate of the entire Johnson grass area permits at least two crops a year to be grown on every acre of land. A crop of winter grain, hay, and one or two summer crops of cow-pea hay or sorghum hay can be grown on the worst infested land, with little or no interference from the grass, if the land is thoroughly plowed and harrowed before planting each crop.

Better than all, however, on land adapted to it, and this includes nearly all the worst areas, alfalfa can be sown on Johnson grass land with perfect success. To do this the land should be plowed and the rootstocks thoroughly harrowed out early in the fall. If, after this, a good beating rain comes to firm the soil, all the better. Then sow the alfalfa, at the rate of 20 lbs. of seed per acre, early enough in the fall for it to get a good start before cold weather. The next summer cut it promptly every time it gets high enough to make a fair crop of hay. This treatment helps the alfalfa and greatly discourages the Johnson grass. As alfalfa makes four or five crops of hay a year in the South (six to nine in some places), and Johnson grass only three, and as Johnson grass gradually declines in yield anyway, so that it yields very little three or four years after the last plowing, the alfalfa will, in a few years, be practically free from the grass. What little is left actually improves the quality of the alfalfa hay.

After what has been said above it might seem superfluous to speak of the proper management of a

Johnson grass meadow. Yet some farmers have a good market for the hay or need it on their own farms. It is also the belief of the writer that when the agriculture of the South is properly diversified, a fact which is being accomplished rather rapidly at present, Johnson grass will not be so much of a pest as it now is, and may occupy an important place on stock-farms. For these reasons it is well to include here a statement concerning its usefulness for hay and pasture.

Johnson grass is not very satisfactory for permanent pastures. Although stock eat it readily and thrive on it, the yield of feed on Johnson grass pastures decreases rapidly from year to year until it becomes unprofitable. Many farmers say it can be killed out by pasturing in two or three seasons, but there is usually enough left to start it again when the land is plowed up. When used only for meadow purposes, a Johnson grass field can be made permanently productive by proper treatment. Like all grasses that throw out abundant rootstocks, it becomes so sod-bound in a few years that the yield of hay is greatly lessened. To correct this it is necessary to plow the land once every two or three years. It may be plowed in either fall or spring. Ordinarily it is best to plow the meadow in early fall and then to harrow it. If this is done regularly every two years the meadow remains productive as long as the fertility of the land holds out. It is to be presumed that it would produce good crops indefinitely with proper fertilization.

Johnson grass seed weighs about 25 lbs. per bushel. The usual amount sown is from a bushel to a bushel and a half per acre. It may be sown either in spring

or early fall. The seed may be drilled, or sown broadcast and covered by harrowing.

The distribution of Johnson grass is shown in Fig. 28, each dot on the map representing a correspondent who reported it as an important grass in his locality. The map shows it to be confined to those portions of the country where the ground seldom or never freezes to the depth reached by the plow. It will be noticed that a well-defined area of Johnson grass extends across the State of Alabama a little south of the centre, turning northward into northeastern Mississippi. Maps showing the distribution of cotton and also of the negro population show this same area in a similar manner. It is due to the peculiar soil of that region. This is a broad, fertile strip of black prairie soil, rich in lime and other plant-food. An examination of the geological map shows this strip to coincide with the rocks of the cretaceous period. With proper drainage, alfalfa does well on this soil. The same soil occurs again in an enormous area in northern and central Texas, forming the famous region of black waxy soil of that State. Johnson grass is perfectly at home throughout this portion of Texas, but it does not, by any means, confine itself to these cretaceous soils in the South.

Few grasses will stand greater extremes of moisture than Johnson grass. It luxuriates in moist soils and along the banks of drainage and irrigating ditches, but is at the same time noted for its ability to resist drouth. It makes very little growth in exceedingly dry weather, but lies dormant, and springs up vigorously as soon as rain comes again.

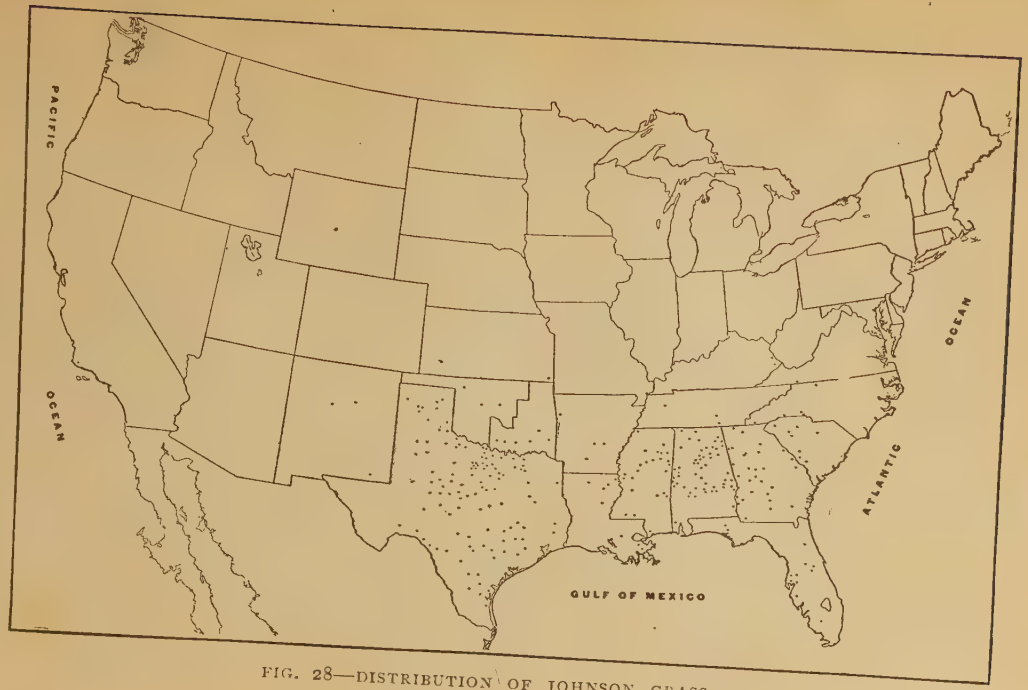

FIG. 28—DISTRIBUTION OF JOHNSON GRASS

X

REDTOP AND ORCHARD-GRASS

THESE two grasses have nearly the same distribution in this country. They are both of secondary importance, compared with timothy. While more widely distributed than any other grass, they are really important in only a few localities, as will be seen in the following:

REDTOP (*Agrostis alba*)

(*Herd's-grass of Pennsylvania and the South*)

Of the perennial farm grasses in the northern part of this country, timothy ranks first; Kentucky blue-grass is a fair second; while redtop (Fig. 29) is a poor third. In only one or two localities does redtop rise to first rank. These are in southeastern Illinois and adjacent parts of Kentucky, and in the New England States. In the first-mentioned region the soil is a heavy clay, inclined to be wet, to which class of soils redtop is particularly adapted. Nearly all the redtop seed of the country is grown in this locality. It rises to considerable importance in New England, and is again more or less prominent in certain sections of the arid West, where irrigation is practiced, and along the southern edge of the timothy region. Over the timothy region, except in New England and the above-mentioned localities in Illinois and Kentucky, it is generally looked upon with disfavor. The most valuable

FIG. 29—REDTOP

service it renders in the great hay-producing States of the Middle West lies in the fact that it invades old timothy meadows, particularly in the low, moist portions of the field, and thus causes the farmer to plow up these old, unproductive sods. It thus increases the average yield of timothy by causing meadows to be laid down anew oftener than they otherwise would be. The distribution of redtop is shown in Fig. 30.

While chemical analysis and digestion experiments show that redtop is more nutritious than timothy, it has little standing either with farmers or on the markets, and its presence in hay in any considerable quantity lowers the market grade of the hay. It is the chief constituent of the "other grasses" referred to in the grades of hay established by the National Hay Association. The basis for the lack of popularity of redtop is found in its comparatively small yield on the one hand and its lack of palatability on the other. It is also a grass that deteriorates rapidly if allowed to stand till over-ripe—more rapidly, at least, than timothy. It is, therefore, not surprising that where timothy thrives, redtop is not generally a favorite. It possesses, however, some redeeming features, and is a most useful grass in its place.

On land that is too wet for timothy, redtop is decidedly the best substitute for that grass. It will even thrive on land too wet for cultivation. In the mountain regions of the West there are many valleys in which there are more or less extensive areas of low, level land, often too wet for the plow, on which redtop is easily started merely by scattering the seed. These meadows are the reliance of the rancher for winter feed,

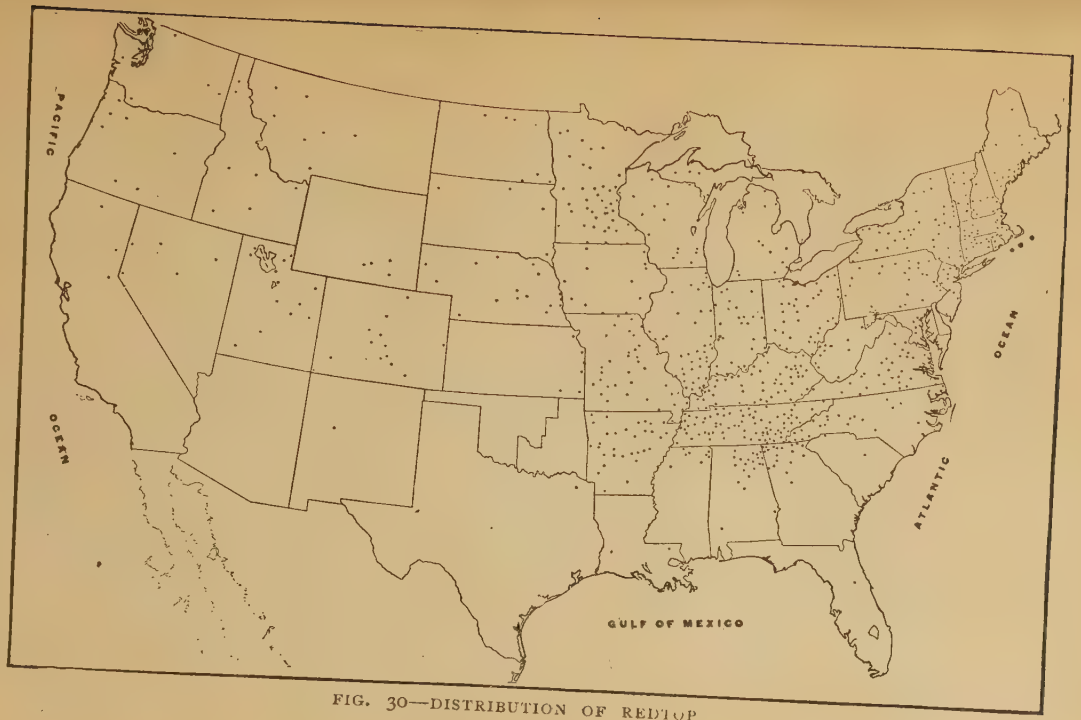

FIG. 30—DISTRIBUTION OF REDTOP

and redtop is justly accorded a high place in the favor of stockmen. Timothy may be started in the same way on meadows that are not too wet. There are also extensive areas of rich overflowed lands in all the timothy-growing States on which redtop, mixed with alsike clover and fowl-meadow grass (*Poa serotina*), is the best and most available grass.

In the New England States redtop regularly constitutes a part of the mixture for meadows and pastures. In the replies to a circular letter asking for the constituents of the usual grass mixtures, redtop was mentioned oftener than timothy in Massachusetts, Connecticut, and Rhode Island. In Maine, timothy led in the ratio of 33 to 27; in New Hampshire the ratio was 32 to 22, and in Vermont, 36 to 10. In the replies from Alabama and Georgia, redtop was mentioned twice as often as timothy, while in Tennessee and North Carolina these two grasses divided honors about equally. In the great hay-producing States of the Middle West, timothy was mentioned from 4 to 20 times as often as redtop. The popularity of redtop in New England is probably due to two causes: First, the area of wet meadow-land is proportionately larger there than it is in the States farther west and south; secondly, the agricultural societies of New England have long been established, and have had a marked influence on agricultural practice. Through these societies the farmers have been more or less imbued with the ideas that pervade English agricultural writings. In English literature and in the minds of English farmers the idea of grass mixtures, of "top" and "bottom" grasses, is thoroughly grounded. The Eng-

lish farmer is well established in the belief that a grass mixture should consist of tall and short and early and late grasses, thereby giving a greater yield and greater palatability to the product. This idea has probably influenced New England farmers to some extent, who grow redtop as a good "bottom" grass—*i.e.*, one which fills the lower part of the swath with leaves.

To illustrate how firmly the idea of mixtures is grounded in the minds of English agriculturists the following instance may be cited. In a recent report from the agricultural department of one of the leading English colleges the results of experiments with seven mixtures, each consisting of from nine to fifteen kinds of seed, are reported. One of the mixtures far surpassed the others, both in yield and in the quality of the hay, and is therefore recommended in the following words: "From the foregoing it is evident that the seeds sown on plat 5 have been by far the most suitable for this soil lying on the Valley Gravel." It so happens that this plat was the only one on which alfalfa was sown in considerable quantity (10 lbs. per acre), and it is stated that the product was chiefly alfalfa. It is safe to say that a farmer from our own Western States would have stated the conclusion differently. He would have said: "Alfalfa is undoubtedly the best hay crop in this test." But it was the *mixture* of nine grasses that was recommended by the experimenter.

The popularity of redtop in North Carolina, Tennessee, and the States to the south (where it is frequently called "herd's-grass") is easily understood. We are here on the border of the timothy region, or

even beyond it. Orchard-grass is popular in this section, and for the same reason. Both of these grasses thrive much farther south than timothy. Redtop is one of the few grasses that remain green the year around in the South; in fact, it will stand greater extremes of climate, as far as temperature is concerned, than any other of our farm grasses, and it is also grown in more States than any other. Florida is the only State in which it has not been mentioned by correspondents. It is of very little value, however, in the central and southern portions of such States as Alabama, Mississippi, and Louisiana. In the hill country of north Louisiana, on moist clay, valley soils, redtop is said to be the best of all the grasses. This grass occurs in a semi-wild state in nearly all parts of the country.

The map (Fig. 30) shows approximately the distribution of redtop as a farm grass. By comparing this map with that on page 161, showing the distribution of orchard-grass, it will be seen that the distribution of these two grasses is remarkably alike. Of the two, orchard-grass is really much the best, but redtop is more generally grown. It is only outside of the limits of the timothy region that redtop becomes second to orchard-grass in the preference of farmers. Orchard-grass yields a larger amount of, and better, hay (if cut right) and more pasture than redtop, and is considered more palatable, but it is surpassed by timothy in most of these respects, and becomes prominent only where it does not have to compete with timothy. Redtop is preferred for sowing with timothy, because it is not so early as orchard-grass and makes a more even sod.

Redtop is the most variable of all the cultivated

grasses. One form has large, erect stems, with broad, coarse leaves. This is the one generally grown for hay, and the seed ordinarily sold as redtop consists mostly of this type. Another form has slender, creeping stems, with much finer leaves, and is known as "creeping bent." Every gradation between these two forms may be found. Some botanists regard creeping bent as a distinct species, but it is generally considered as only a variety of redtop. This creeping form is quite commonly used as a lawn grass along the north Atlantic seaboard.

The various forms of redtop are all good pasture-grasses, particularly on moist soils. They make a good sod, and bear cropping and trampling well. Redtop seed is sold both in the chaff and as "recleaned" seed. The latter is simply the ordinary seed from which most of the chaff has been removed. The ordinary seed weighs 10 to 12 lbs. per bushel, the recleaned weighs 35 lbs. per bushel.

The amount of redtop seed used in the usual grass mixture of New England varies greatly. Some farmers sow it very sparingly, using only one or two pounds per acre (of recleaned seed); others make it the principal ingredient of the mixture, using 12 to 18 lbs. If ordinary seed is sown, about four times these amounts should be used in order to get the same amount of seed. The recleaned seed is usually cheapest in the long run.

In recent years the development of the rice industry in Louisiana and Texas has seriously interfered with the rice-growers of the Atlantic coast region, and they are now casting about for grasses and forage

plants to grow on their rice-fields. Redtop is a grass that is worth trying for this purpose. It may not prove to be adapted to the climatic conditions of the section in question, but it is adapted to that class of soils.

ORCHARD-GRASS (*Dactylis glomerata*)

(*Cocksfoot of England and New Zealand*)

Orchard-grass (Fig. 31) illustrates well the fact that after the agricultural authorities have had their say, the farmer himself is the court of last resort in all matters of farm practice. All over the timothy region orchard-grass has been repeatedly urged upon the farmer by agricultural writers, but the farmer, for the most part, has just as persistently refused to grow it. This grass also illustrates another fact—namely, that a grass may have many excellent qualities, and yet be outclassed by other grasses because of one or two apparently minor faults. We have seen that blue-grass, in spite of its low yield, its failure in midsummer, and the difficulty of securing a sod of it, is still the great pasture-grass in this country (in the North), because of its palatability, its high nutritive quality, its increase of yield with age, and the pleasing appearance of the sward.

Orchard-grass is the earliest grass to start up in spring, remains green during long, hot summers and late into the fall; it furnishes abundant feed, and is fairly well liked by stock; but it grows in tussocks, and therefore does not make an even sod. It must also be cut promptly when grown for hay, or its quality rapidly deteriorates. The seed is also expensive.

FIG. 31—ORCHARD-GRASS

These faults seem to be at the basis of the aversion which most farmers in the timothy region have for this grass. There is really no good reason why the seed should cost more than blue-grass seed, except that the supply of it is more limited. It produces an abundance of good seed (fifteen to eighteen bushels per acre, according to Prof. H. J. Waters, of the Missouri Experiment Station), and it is easily harvested. If this grass were grown as plentifully as timothy the seed would probably be nearly as cheap.

At present orchard-grass seed is produced in quantity only in the highlands of western Virginia and contiguous regions, and in two counties on the Ohio River—one in Indiana, and the other opposite, in Kentucky (see Fig. 9). This latter locality produces the bulk of the orchard-grass seed grown in this country. Small quantities are produced in a few other localities. Grass-seed production seems to be quite generally confined to certain localities. There is some advantage in this. There is a good deal to be learned in the business of seed-growing, hence most farmers are slow to take it up. When a community gets started to growing seed, neighboring farmers learn from those who first begin, a good local market is established, cleaners are built, and the business finally becomes general. It is probable that orchard-grass seed could be produced at a profit in many localities where little or none is now grown. But since the demand for it is quite small it would not be difficult to overstock the market.

Perhaps the most serious fault orchard-grass possesses is its tendency to become woody soon after the

blooming period is over. When cut during or just after bloom it makes hay of superior quality, but if left a week or ten days later it makes very poor hay. This is more or less true of all our farm grasses, but it seems to be more pronounced in the case of orchard-grass than most others. The author has fed orchard-grass hay extensively to horses and cattle with excellent results, but it must be cut as stated above or stock do not eat it readily. It is not always possible to cut hay at the proper time; other farm work may be pressing, or unfavorable weather may delay haying. It is therefore safer, when practicable, to grow a grass like timothy, which does not have to be cut so promptly, though even timothy should be cut before the seed is ripe to secure hay of the best quality. Another reason why farmers do not like to grow much orchard-grass is that timothy is the standard hay in all city markets, and even better hay than timothy will usually sell at a lower price because horsemen know what timothy hay is and are not familiar with orchard-grass hay. How the two would stand in the favor of feeders if both were equally known has never been determined. Experimenters have very generally recommended orchard-grass very highly. The fact that, in actual farm practice, orchard-grass hay would be cut at all stages from blooming to maturity of the seed, would undoubtedly make the quality of the hay very irregular, and thus render it unpopular.

The uneven character of orchard-grass sod, as seen in Fig. 32, also tends to render it unpopular with farmers. It is no small task to ride a mower over an orchard-grass meadow. The small tussocks which

from the sod give the mower a motion similar to that of a wagon driven over a rocky road. This defect of orchard-grass sod can be partially overcome by sowing clover and meadow-fescue with it; but the latter grass

FIG. 32—SOD OF ORCHARD-GRASS

is little grown in this country, for reasons that will be mentioned later.

One of the most important advantages orchard-grass possesses is that it ripens exactly with red clover, and is thus eminently adapted to sowing with that important leguminous plant. It is a week to ten days earlier than timothy; indeed, it is one of the earliest of our grasses to furnish green feed in spring, and is therefore a valuable constituent of pasture mixtures. It

is somewhat amusing to read the severe condemnations of orchard-grass—and timothy, too, for that matter—in English books on grasses of the early part of the last century, on account of its coarseness. This idea crops out, to some extent, in American literature; but there is nothing to support it. If stock relish a grass and it is nutritious, then the coarser the better—if coarseness adds to the amount of forage it yields. Corn is rather a coarse grass, yet it is the most valuable of all grasses. Sorghum is another coarse grass that makes hay, and particularly green feed, of excellent quality.

Another advantage orchard-grass possesses is its greater length of life. If properly treated an orchard-grass meadow continues to make good yields for many years, but, like most other perennial grasses, it produces more the first cropping season than ever afterward, except under unusual weather conditions, and it is doubtful if a farmer would be justified in keeping an orchard-grass meadow down more than two or three years. It also possesses marked advantages as a pasture-grass if grazed systematically. It bears cropping and trampling better than timothy, but does not continue to improve in old pasture-lands, as blue-grass does. It is worthy of a place in grass mixtures wherever it will thrive. It is stated by many writers that sheep are especially fond of it.

The author can state from experience that horses and cattle eat it readily in pastures, but if mixed with other grasses and clover, and poorly managed, orchard-grass is inclined to outgrow the other constituents of the mixture, and when clumps of it attain considerable hight, stock neglect it for more tender herbage. If

the pasture is allowed to rest until there is considerable growth upon it, and then sufficient stock is turned in to eat it down quickly, orchard-grass is eaten with the rest. It has already been pointed out that this is the best method of getting the most feed from pastures, though it is not always practicable to follow it. Orchard-grass revives quickly after being cut for hay or cropped by stock, especially if there is plenty of moisture in the soil. In favorable seasons it yields two cuttings of hay a year—another characteristic which adapts it to sowing with red clover.

The distribution of orchard-grass in this country is approximately shown in Fig. 33. This map was prepared in the same manner as that showing the distribution of blue-grass (Fig. 19). Each dot represents a correspondent who reported it as an important grass in his locality. An examination of the map shows that it is found most commonly around the southern border of the timothy region; in fact, it is decidedly the best of the farm grasses in that portion of the country, and is deservedly popular there. It is most important as a hay grass in Virginia, northern and western North Carolina, northern Georgia, northern Alabama, in Tennessee, and in those portions of Kentucky in which timothy does not thrive. In the regions here outlined timothy does well only on the best alluvial soils, and is liable to be entirely killed by the summer heat. Orchard-grass is here adapted to a large variety of soils, and yields abundant crops of hay and pasture. It is better understood here than farther north.

Orchard-grass is also grown considerably in Missouri, Kansas, Colorado, Utah, Idaho, Oregon, Wash-

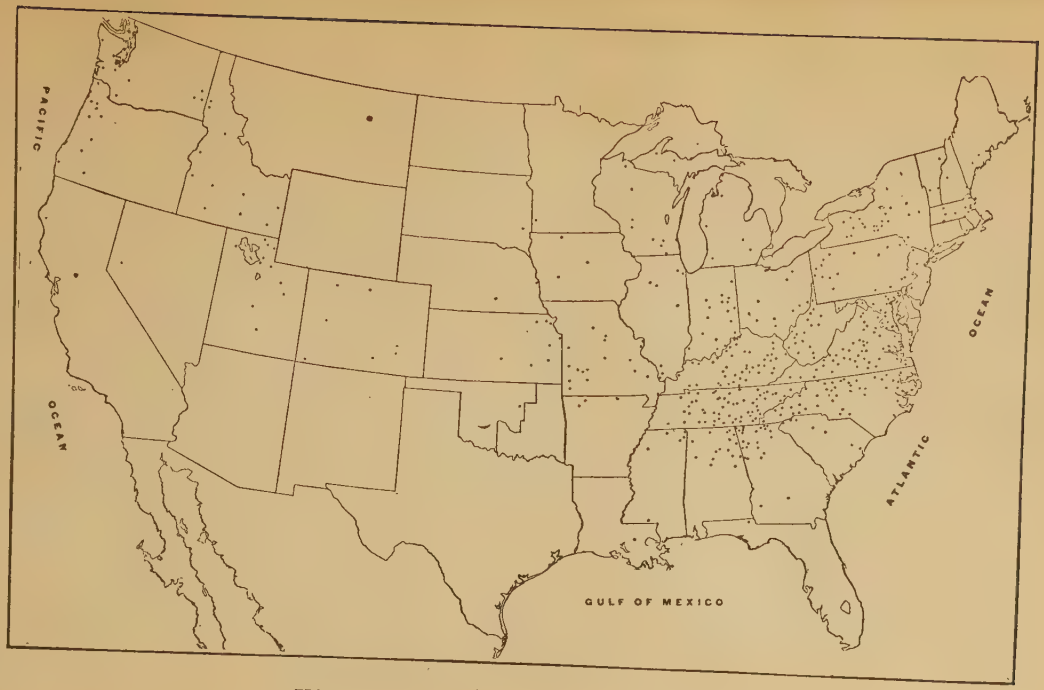

FIG. 33—DISTRIBUTION OF ORCHARD-GRASS

ington, and northwestern California. Along the Pacific Coast west of the Cascade Mountains orchard-grass thrives remarkably well, and this is one section in which it vies with timothy in a timothy region. The worst disadvantage which it possesses in this section is its earliness. In all the region west of the Rocky Mountains the rains fall mostly in winter, while the summers are dry. West of the Cascades in Oregon, and more particularly in Washington, orchard-grass is frequently ready to cut before the spring rains are over, and it is therefore not always possible to cure the hay. Timothy comes on about ten days later, and thus stands a better chance of finding favorable haying weather. This objection does not hold east of the Cascades and in the Rocky Mountain region. In the Mountain States orchard-grass is much prized as a companion to alfalfa. It matures with the first cutting of alfalfa, and improves the quality of the hay. It is also a valuable grass to mix with alfalfa for pastures, greatly reducing the risk from bloat, and it has no tendency to spread and choke out the alfalfa.

Orchard-grass occurs sparingly throughout the timothy region, but is nowhere an important grass in that area, except in a few small sections previously mentioned. It is used considerably in New England and adjoining States as a constituent of meadow and pasture mixtures, and probably deserves to be much more generally used for pasture purposes all over the Northern States.

Orchard-grass seed, as found on the markets, is usually of good quality. It weighs about 14 lbs. per bushel. When grown for seed, it yields ordinarily 15

to 18 bushels per acre. The retail price of the seed varies from 15 to 25 cents per pound. When sown alone, 20 to 25 lbs. of good seed per acre is sufficient. In pasture mixtures, 3 to 6 lbs. are usually sown.

This grass is highly prized in New Zealand, where it is known as "cocksfoot," as it is also in England. This name is derived from the fancied resemblance of the spreading seed head to a chicken's foot.

XI

BROME-GRASS (*Bromus inermis*)

BROME-GRASS (Fig. 34) is one of the few recently introduced grasses that have won a permanent place in American agriculture. Its introduction is to be credited to the work of the State experiment stations and the National Department of Agriculture. It has been grown by them experimentally for a good many years, but began to attract general attention in the early nineties. It was at first heralded by enthusiastic seedsmen as a panacea for all the ills of the farmer. Without question it is the best pasture-grass yet found for the Prairie States of the Northwest and Pacific Northwest. On the great wheat-producing soils of the sections mentioned it is a pasture-grass unequaled in productiveness by any other pasture-grass in the country (unless we except the Bermuda grass of the South), and surpassed only by blue-grass in the quality of its herbage. It is now firmly intrenched in the favor of farmers from Kansas to the Canadian line and west to the Cascade Mountains of Oregon and Washington. It is also a valuable grass for moderately dry uplands in parts of California. It is distinctly a Northern grass, having never succeeded south of the latitude of St. Louis, except at high elevations in the Mountain States. It is perfectly hardy, even in Manitoba. In the dry summers of the Northern Pacific Coast region (east of the Cascade

FIG. 34—BROME-GRASS

Mountains) it furnishes more green feed than any other of the true grasses. Noted for its ability to withstand drouth, it yet does well on good moist soils. It will not thrive, however, on soils that are distinctly wet. It is particularly at home in the Red River Valley of North Dakota and on the peculiar basaltic soils of eastern Washington, eastern Oregon, and northern Idaho. Its distribution is shown in Fig. 35, each dot representing a locality from which correspondents report it important. It is generally supposed that brome-grass is not adapted to the more humid climate of the timothy region, but the fact is it is nearly or quite as valuable over much of this region as it is farther west. In the West it had no competitors as a pasture-grass, while in the East it had to compete with several long-established and highly satisfactory grasses, particularly timothy and blue-grass. It has already been stated that nearly all the grass literature issued by the State experiment stations comes from those stations outside of the region of timothy, blue-grass, and red clover. Having very satisfactory meadow and pasture crops, the farmers of the timothy region have not given brome-grass a thorough trial. As an illustration of the attitude of these farmers toward new candidates for their favor, we may quote the remark of an Ohio farmer when asked, in a circular letter, what were the hay and pasture problems of his section. "We have no problems of this kind," was his reply. "What we need is to know how to build barns more cheaply and how to handle our livestock better. Our meadows and pastures already produce as much feed of the best quality as land can be made to produce." This may

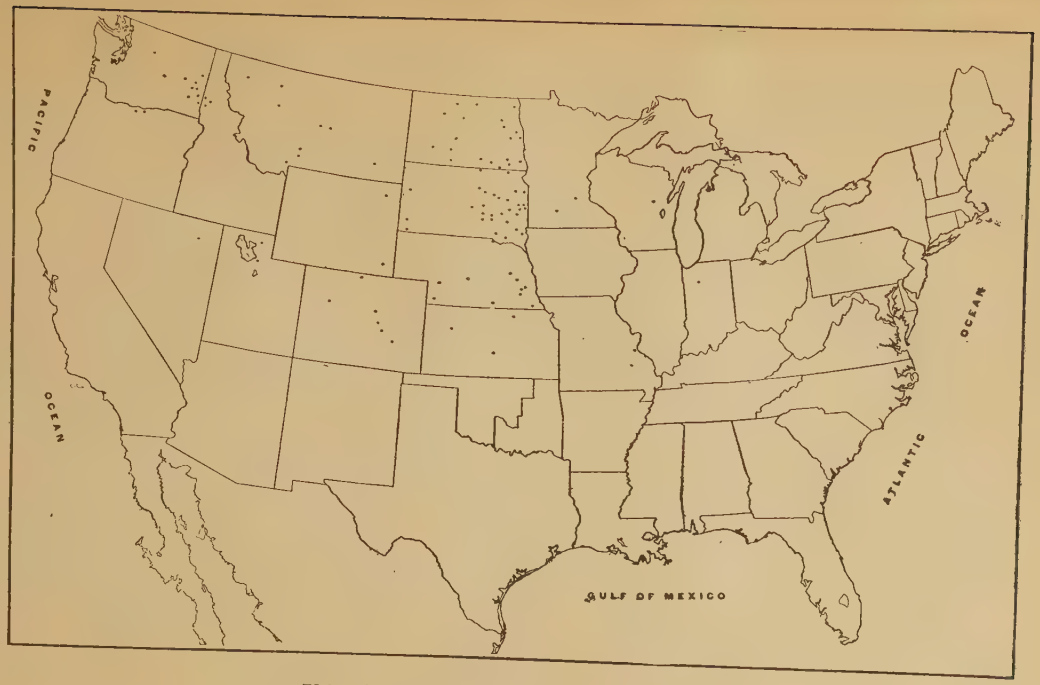

FIG 35—DISTRIBUTION OF BROME-GRASS

or may not be true, but it shows that grass problems are not pressing in that section. Yet it is probably true that brome-grass would add much to the productiveness of pastures, even in Ohio. J. E. Wing, the well-known agricultural writer and lecturer, whose farm is in west central Ohio, says that a mixture of brome-grass and alfalfa will carry six times as much stock there as blue-grass, and do it better. Yet both of these crops are, or were until very recently, nearly unknown in that State. Alfalfa is now rapidly gaining favor throughout the timothy region, and it is probable that brome-grass will, in time, do the same over much of this region.

It has been stated on a previous page that palatability is perhaps the most important single characteristic of a grass. If stock like it sufficiently well to eat enough to fatten on, it deserves attention. It is not claimed that brome-grass is as palatable as blue-grass, but the former is eaten readily by all classes of stock, and its superior productiveness would render it more profitable than blue-grass in all sections except those where blue-grass is at its best, such as the Blue-Grass Region of Kentucky, north Missouri, and southwestern Iowa. Since brome-grass is more a pasture than a hay grass, and as the farmers of the eastern part of the timothy region are gradually abandoning the use of pastures in favor of more productive methods of raising feed, it is doubtful if brome-grass has an important place to fill in that section. But farther west, where beef production renders pastures necessary, it would undoubtedly add to the profit of the farmer.

Brome-grass was at first heralded as a great hay-

producing grass, but it has been a disappointment to many farmers in this respect. The disappointment was due to too great expectations. It does produce a fine crop of hay, apparently the equal of timothy, for one or two years, but by the third year, except on very rich, moist land, it becomes so sod-bound that it sends up very few seed-stalks, though it continues indefinitely to produce an abundance of short, leafy growth, excellent for pasture. A few instances are reported in which farmers have plowed the sod in the fall and harrowed it down smooth, thereby renewing it to full vigor as a hay producer. Experience in this line is yet too meagre to justify the assertion that this practice would be generally successful. It is certainly worth trying.

Brome-grass hay is not yet sufficiently known on the markets to enable us to pass final judgment upon it. Experiments have demonstrated that it is as nutritious as timothy, and abundant experience shows it to be relished by stock. But the same is true of several other kinds of hay that have little standing on the markets. It requires long experience of many feeders to settle the status of any kind of hay. The men who feed livery horses in the cities are the jury that passes final judgment in matters of this kind, and their dictum furnishes the market rating of all classes of hay. When we have learned more about how to grow brome-hay, and its true value has been determined by the feeder, it may become a standard, particularly in the markets of the Northwest. Like timothy, it possesses the advantage of producing good seed in abundance. The seed is easily harvested, and may be threshed on

an ordinary grain-thresher with proper riddles and proper control of the draft. The straw, after the seed is threshed out, is readily eaten by stock. This grass produces rather abundant aftermath, which furnishes excellent grazing. On the approach of winter it turns brown, but does not lose its palatability, and it furnishes good pasture, even under light snow.

Brome-grass is usually sown in spring, at the rate of 20 lbs. of good, clean seed per acre. The seed does not feed well through ordinary drills, and it is best to sow it by hand. Like most permanent grasses in the North, it makes very little growth the first year from spring sowing, though it makes good pasture from midsummer on. The next year it makes a fine crop of hay. On the best soils it makes a good crop still another season, but then begins to get sod-bound, after which its best use is for pasture, unless it is plowed up and harrowed in fall, as previously suggested. West of the Rockies it is best to plow the land for brome-grass in early spring, shortly before sowing. East of the Rockies fall plowing is advisable. In the sections where brome-grass is now well established it is not wise to sow it with a nurse crop. Farther east, where there is more summer rain, it could be sown advantageously with any kind of spring grain. East of the Dakotas it could be sown in late summer with excellent results. Sown thus, it ought to make a full crop the next year.

Until recently most of the brome-seed sold by dealers was imported from Central Europe, where this grass has been a standard for more than half a century (Southern Russia and Northern Austria). On account

of the absence of laws in this country to protect farmers against worthless seeds, the quality of imported brome-seed has been generally very poor. In growing this seed it is extremely important to allow it to ripen thoroughly. This can be done, as the grass holds its seed well. It is best to let it stand till it begins to shatter a little, unless the grower is expert enough to tell by other signs when it is ready to cut. If cut too early the seed is so light that it cannot be cleaned properly and will not germinate readily. Brome-seed of the highest quality is grown in eastern Washington and northern Idaho, where this seed is a standard on the markets. Good seed is also produced in the Dakotas and neighboring States.

In sod-forming character brome-grass is much like blue-grass, but is much coarser, and not so pleasing in color. The one character which first gained recognition for it in this country is its ability to grow under adverse climatic conditions. It is not a desert grass by any means, but, in cold climates, it will grow on as dry land as any of the tame grasses. It has about the same ability to grow on dry land as alfalfa, but, unlike the latter, it does not thrive in warm climates.

Brome-grass has had several names applied to it by seed dealers and agricultural writers, such as "awnless brome," "Hungarian brome," "Russian brome," "Russian forage grass," "beardless brome," etc., but the farmers who grow it use the simple name "brome-grass." It is frequently confused with the so-called broom-sedge grasses of the South and West —grasses very different from it in all essential characters.

FIG. 36—CHESS, OR CHEAT

There are several native species of the genus Bromus which are more or less promising under cultivation, especially on dry lands west of the Rocky Mountains. Two of these are worthy of attention—namely, *Bromus marginatus* and *Bromus carinatus*. Both of these wild species are very variable, and some forms of them are undoubtedly valuable. Their possibilities are being exploited by the experiment stations in the West. As yet they have no satisfactory common names. One farmer in a dry section of southwestern Oregon grows *Bromus marginatus* under the name of "eight-dollar grass," having secured his start of it from the side of a mountain bearing that name. It is hoped that suitable local names for them may become well enough established to warrant their general use.

Another representative of this genus is the well-known cheat or chess (*Bromus secalinus*), Fig. 36, of the grain-fields. In the Willamette Valley, Oregon, and in the Blue Mountains of the same State, cheat is grown for hay to a considerable extent. It is an annual, adapted to sowing in the fall. It yields quite well, but the hay is not of high quality.

The rescue-grass (*Bromus unioloides*), Fig. 37, of the South is another representative. This is also an annual. In south central Texas this grass grows wild quite generally. It is occasionally sown for winter pastures throughout the South, for which purpose it has some value, but it possesses few, if any, advantages as a winter pasture in that section over the common cereals. It would probably thrive a little farther south than the cereals. In Georgia and adjacent States rescue-grass is frequently sold under the name

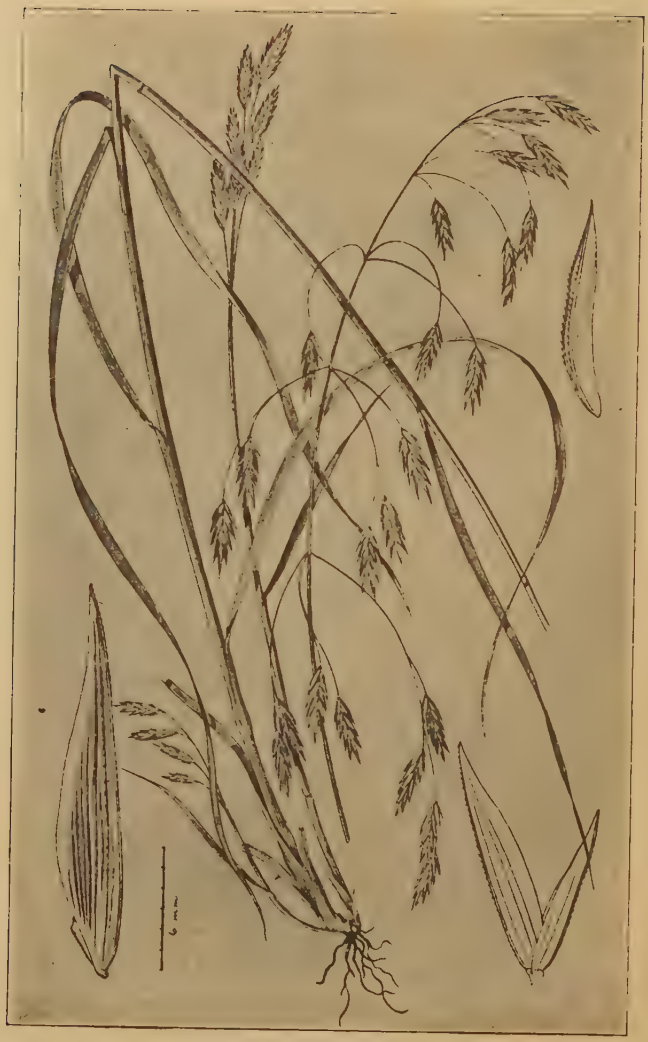

FIG. 37—RESCUE-GRASS

"Arctic grass." This name was given by a seedsman, with a view to inducing farmers to grow it more generally. A few Southern seedsmen sell cheat-seed for rescue, some using the latter name and some the name "Arctic grass." There is considerable advantage to the seedsman from this practice, for he can get cheat-seed very cheap at the large grain elevators of the Central West. Men who practice this deception console themselves with the idea that, after all, cheat is about as good a grass as rescue. They are wrong in this. In addition to making hay inferior to rescue hay, it makes less abundant winter pasture, and in some places is a bad weed in grain-fields.

XII

GRASSES OF MINOR IMPORTANCE

OME of the grasses discussed in this chapter are the most important grasses of Europe. It is somewhat difficult to account for the lack of appreciation they find among our farmers.

MEADOW-FESCUE AND TALL FESCUE

(*Festuca pratensis* and var. *elatior*)

Meadow-fescue is frequently called "English blue-grass"—an unfortunate name, since it leads to confusion; it is not a near relative of our blue-grass. And another very different grass (*Poa compressa*) is called "Canadian blue-grass," and sometimes "English blue-grass." Meadow-fescue is one of the most important grasses of England and the Continent of Europe, being rivaled there only by the rye-grasses. It has been repeatedly urged upon the American farmer, but he has persistently refused to grow it. Some of the reasons for this are as follows: In most of the region adapted to it in this country it does not yield so well as timothy. Its seed is costly, and it requires more to seed an acre than it does of timothy. In addition to this, meadow-fescue seed is not nearly so reliable as that of timothy, and is more adulterated, for there are many other seeds

closely resembling it. Much of the fescue-seed sold in America is imported, and in consequence of our lack of laws on the subject, as stated before, it is frequently the refuse of the European trade. Add to this the well-established position of timothy hay as the standard on our own markets, and we have an indictment that would convict any grass. The difficulty of securing good seed cheaply, the uncertainty of securing a stand even with good seed, and the relatively low yield as compared with timothy, probably account for the lack of recognition of meadow-fescue in this country. Nevertheless, stock show a decided preference for this grass. In experiments with cattle turned into a grass-garden where several hundred grasses and legumes were growing, meadow-fescue and tall fescue were always eaten in preference to all others except the rye-grasses.

Meadow-fescue is occasionally met with in New England, New York, Pennsylvania, eastern Kentucky, and very sparingly elsewhere in the timothy region. In eastern Kansas it rises to considerable importance, and a great deal of seed of it is grown there and in adjacent counties in Missouri. Like most all the less-known grasses, when it occurs at all in this country it is near the outer margin of the timothy region.

In Oregon, Washington, and northern Idaho meadow and tall fescue are regarded with considerable favor. On the basaltic wheat-producing soils of eastern Washington and northern Idaho tall fescue, when a good stand of it is secured, is undoubtedly one of the best grasses, both for hay and for pasture. If the difficulty in securing a good catch could be mas-

tered, it would probably become a standard in that section.

Tall fescue differs very little from meadow-fescue, except in being more robust in habit. It grows four to six inches taller, and it appears to be somewhat more difficult to get started. This may be due to poorer quality of the seed ordinarily secured from dealers. Tall fescue seed is very seldom called for, and is about three times as high-priced as meadow-fescue seed. It also weighs only about 14 lbs. per bushel, while meadow-fescue seed weighs 22 lbs. The difference is due mainly to a greater amount of chaff left in tall fescue seed, thus masking, to some extent, its higher price.

American farmers have not had experience enough with these two grasses to determine the proper amount of seed to sow per acre. Both grasses are perennials, and outlast timothy, both in meadows and in pastures.

While it has not been demonstrated, it is probable that mixtures of such grasses as the fescues, rye-grasses, orchard-grass, timothy, redtop, and red, white, and alsike clovers, would make pastures far surpassing blue-grass on all soils in the timothy region, except in a few areas already referred to as special blue-grass regions. Mixtures such as the above are generally used for pastures as well as meadows across the Atlantic, and European farmers find pastures profitable, even on high-priced land. Perhaps American farmers would not be abandoning pastures as they are if they did not rely so entirely on blue-grass and white clover.

THE RYE-GRASSES: ENGLISH RYE-GRASS (*Lolium perenne*)—ITALIAN RYE-GRASS (*Lolium italicum*)

These grasses are even less popular in this country than the fescues; in fact, they are practically unknown here, except on the Pacific Coast west of the Cascade Mountains, and in a few places in the South. Yet they are the most important grasses of Europe. It is not at all easy to account for their lack of popularity on this side of the Atlantic. Stock certainly prefer them to all other cultivated grasses; their seed is fairly reliable, though their scarcity in the markets renders them high-priced, and they yield well on soil suited to them. Although they do not yield so well as timothy, it would seem that the superiority of the herbage they produce ought to give them a place among American farm grasses. There is, of course, the same difficulty with their seed that is met with in the case of most imported grass-seed: we get only inferior quality, as a rule. The fact that more seed per acre is necessary than is the case with timothy, and that it is more costly, added to the somewhat poor quality of seed found in our markets, probably accounts, to some extent at least, for their lack of standing. It may be, too, that they are not adapted to our climatic conditions, for it is frequently the case that crops that flourish in Western Europe are adapted only to our Pacific Coast States. Certain it is that the rye-grasses have gained no foothold to speak of in this country, except on the Pacific Coast.

On irrigated plains in northern Italy, and on sandy lands in the vicinity of Edinburgh, Scotland, irrigated by sewage from the city, Italian rye-grass yields enor-

mous quantities of forage. In the latter locality, according to Storer, it is cut four or five times in a season. Italian rye-grass is practically an annual, but by letting it ripen seed before cutting the hay, which it is perfectly safe to do as far as quality of the hay is concerned, it reseeds itself, and is thus to all purposes a perennial. The old plants do not actually die at the end of the first year, but they do not amount to anything after the first crop year. English rye-grass is little better in this respect, though it is called a perennial. The European farmer thoroughly understands these grasses, and under his care they are the best of all the tame grasses. The American farmer has never been noted for bestowing especial attention to his grass-fields. He prefers a grass like timothy, that does not need careful attention, though he loses much from the usual manner in which he handles his timothy meadows.

West of the Cascade Mountains, in Oregon and Washington, and in the corresponding portion of northern California, Italian rye-grass has gained considerable popularity. It does particularly well on moist lands reclaimed by dyking. It is not generally met with in that section, but a few farmers prize it highly. It grows well on irrigated lands in central Washington, and on the upland wheat soils of that State and northern Idaho, near the mountains where the rainfall is ample, but in the latter region it does not grow a strong straw and is liable to lodge badly in unfavorable weather.

ENGLISH RYE-GRASS is interesting from a historical point of view, as it was the first of the true grasses

to be grown under domestication for hay and pasture purposes. To the early English farmer all grasses were alike. No attempt was made to separate them and secure pure seed of the various kinds. When the attempt was made, this was the first grass of which pure seed was placed on the market, and the conservative English farmer has stuck to it now for nearly three centuries. It was introduced from England into Germany and France. In the language of both these countries, in order to preserve the English pronunciation, the word "rye" was spelled *r-a-i*. It seems that some later English writers imported this word back into English, changing the *i* to *y*, thus producing the term "ray" grass, sometimes used for the rye-grasses. The name "rye-grass" is somewhat unfortunate, since it leads to confusion. The rye-grasses are not at all like the common cereal bearing that name. Neither are they like the so-called wild rye-grasses of our Western States. But this is not a matter of much importance, because of the small part these two grasses seem destined to play in American agriculture.

ITALIAN RYE-GRASS is sometimes used to secure a quick growth on lawns where blue-grass is not easily grown. This is particularly the case around Washington, D. C. It is very useful for this purpose. As stated elsewhere, it is probable that the rye-grasses would prove useful in pasture mixtures in much of the region in which blue-grass is now the standard grass.

The seed of the rye-grasses weighs about 20 lbs. per bushel. Seedsmen recommend two to three bushels of seed per acre when sown alone. In mixtures

the amount of seed should be reduced approximately in proportion to the number of grasses in the mixture.

TALL MEADOW OAT-GRASS (*Arrhenatherum avenaceum*)

This is a grass of comparatively small importance in the United States. It has two serious faults, each of which greatly reduces its value. In the first place, it is not very well liked by stock, though it is possible to get them to eat it readily after they become accustomed to its peculiar flavor; secondly, it has decidedly poor seed habits. Within twenty-four hours after the seed starts to ripen it begins to fall. In the case of a small field of this grass, which the writer grew for seven years at the Washington State Experiment Station, one season it was noticed on Saturday evening that the seed in the top of the panicles was beginning to turn brown. It had been closely watched with a view to saving the seed. On Monday morning the grass was cut with an ordinary grain-binder, yet fully half the seed was lost, partly by falling out before cutting, and partly from shattering in the subsequent handling. Even if it had no other fault, this one would render it impracticable for general cultivation. The writer has met only one farmer who was enthusiastic over the merits of tall meadow oat-grass. This was in eastern Tennessee, on the edge of the timothy region. In the timothy region proper it is almost unknown. It occurs sparingly all over the country, but is nowhere of great importance, and is adapted to a considerable variety of soils. The only reasons for its occurrence in America at all are that it will thrive

in warmer climates and on drier soils than timothy, it is fairly easy to secure a stand, and continues productive for many years. Like orchard-grass, it does not become sod-bound, unless the seed is allowed to ripen and fall, stands pasturing well, and remains green till late in winter. Tall meadow oat-grass matures exactly with orchard-grass and red clover, and is therefore adapted to sowing with these crops.

VELVET-GRASS (*Holcus lanatus*)

The only part of the United States in which velvet-grass occurs to an extent worthy of notice is on the Pacific Coast west of the Cascade Mountains, from northern California to the Canadian line. In that section it is indifferently called "velvet-grass" and "mesquite." The latter name should never be applied to this grass, as it is used for several other very different grasses in the Southwest. In England it is known by several names, the commonest being "velvet-grass," "meadow soft grass," and "Yorkshire fog." The word "fog" in this connection is an old English word meaning the winter growth on meadows. It is applied to this grass from its habit of producing considerable green herbage in winter. It is generally regarded as a pest on the Pacific Coast, particularly on lands that are very wet in winter and very dry in summer. This is especially the case with both sandy and peaty soils on the Coast. It is not utilized for feed in many localities, but on the extensive areas of very sandy land around the mouth of the Columbia River, and at one or two points inland, it is the chief reliance, both for hay and for pasture. It yields ordinarily about half a ton of

FIG. 38—CRAB-GRASS

hay per acre. The hay is remarkable for its lightness, a ton of it being much more bulky than a like weight of other kinds of hay. Horses and cattle nearly starve before they acquire a taste for velvet-grass, but when the taste is once acquired they thrive upon it remarkably well, showing that it is highly nutritious. The whole plant is covered by a growth of wool-like hairs, from which fact the name is derived. It is unworthy of attention except on the classes of soils above mentioned. On these soils it drives out all other grasses.

MISCELLANEOUS GRASSES

CRAB-GRASS (*Panicum sanguinale*).—This grass (Fig. 38.) is of considerable importance in the South. Its distribution is shown in Fig. 39. It is not a cultivated grass in the ordinary sense, as its seed is never sown. It comes up as a weed in corn-fields after the last cultivation, and furnishes no inconsiderable amount of pasture. A considerable proportion of the hay produced in the South is made from this volunteer growth of crab-grass. The yield is light, seldom exceeding a ton per acre, and the hay is of only moderate quality. It has a very good standing with Southern farmers, but is not often seen on the markets. It is mostly fed on the farms where it is grown.

CARPET-GRASS (*Panicum compressum*).—This is an important pasture-grass in eastern Texas, Louisiana, southern Mississippi, southern Alabama, and parts of Florida. It sends out long, creeping stems which root at the joints, and form a very dense, even carpet of sod, whence its name. Stock are very fond of it, and it is highly prized where it grows. On sandy lands

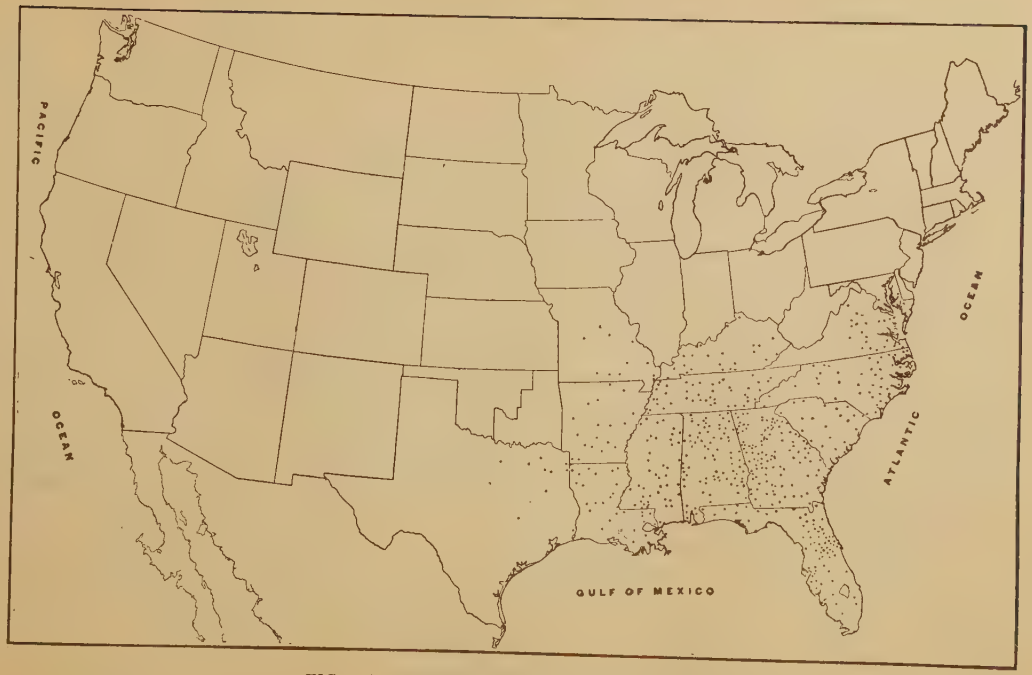

FIG. 39—DISTRIBUTION OF CRAB-GRASS

that are heavily pastured carpet-grass will run out Bermuda grass. It produces very little seed, which is difficult to gather. An occasional method of seeding land to carpet-grass is to mow it at a time when ripe seed is most abundant, and scatter the dry hay on the land to be seeded. This grass does not thrive very far from the Gulf Coast. It seems to prefer uplands, and thrives on either sandy or clay soils. It is a splendid pasture-grass, but does not compare with Bermuda grass in the amount of forage produced. The distribution of carpet-grass is shown in Fig. 40.

Slender Wheat-grass (*Agropyron tenerum*). —Of the many valuable wild grasses of our Western plains and mountain regions, slender wheat-grass is one of the few that are promising on cultivated land. It does well on land entirely too dry for timothy, and stands the most rigorous winters. Whether it possesses any advantages over brome-grass for cold, dry climates is not fully determined. It does not become sod-bound like the latter, and may therefore prove to be better for meadows. As the seed is now available on the markets it is probable that the possibilities of slender wheat-grass will be determined in the near future. It is worth trial.

Agropyron divergens, the great "bunch-grass" of eastern Washington, eastern Oregon, and northern Idaho, and a near relative of slender wheat-grass, is also a promising grass for the driest cultivated lands in the region where it is native. It yields a fair crop of very good hay on drier lands than any of the cultivated grasses. Its seed is sometimes offered by Western seedsmen, but it is somewhat unreliable.

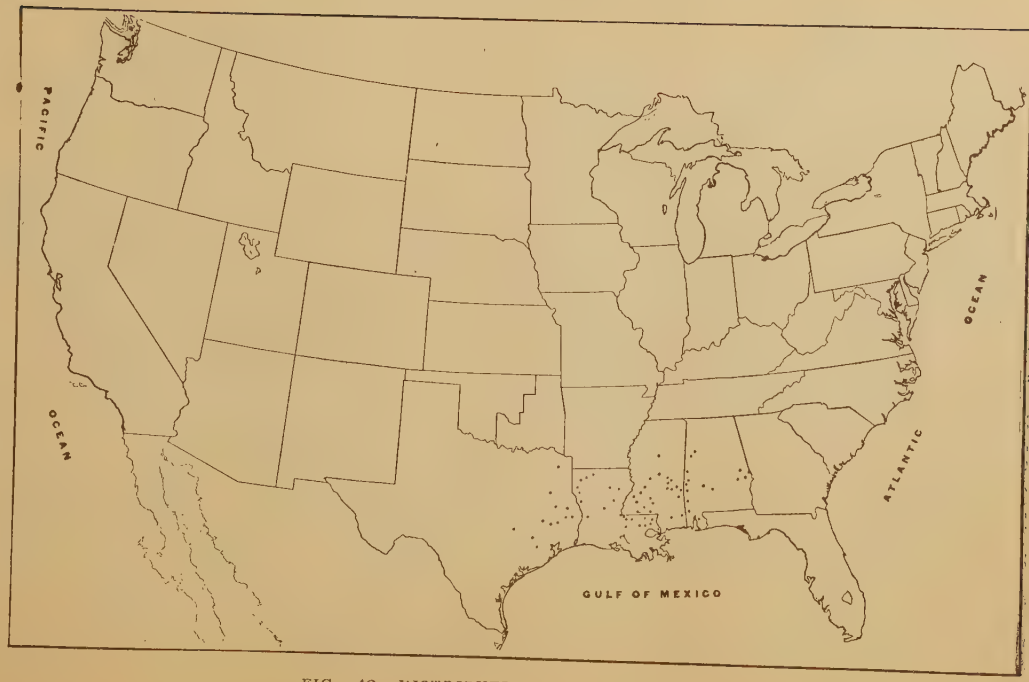

FIG. 40—DISTRIBUTION OF CARPET-GRASS

Agropyron occidentale, the well known "bluestem" of Montana and Colorado, is the most valuable of all the *Agropyrons*. It has been heralded as a great dry land grass. It is adapted to a great variety of conditions, but is most useful on irrigated meadows in the vicinity of Harlem, Montana, where it is extensively cut for hay. In Colorado it constitutes an important part of the upland hay. In the Dakotas, prairie sod, when plowed up and left to itself, is soon covered by a growth of bluestem. In yield, on well-irrigated land, it equals timothy. Where its hay is well known it usually sells at a slight advance over timothy. Horses are especially fond of it, and it is very nutritious. This grass is somewhat weedy in character, having strong underground stems, and is difficult to eradicate when once established. Yet it is not bothersome in grain-fields. In order to keep bluestem meadows in a productive condition, it is necessary to break them up every three or four years. (A plat of bluestem in the grass-garden of the Department of Agriculture is seen in Fig. 41.)

There are a few other wild grasses of the West that may prove valuable for hay production on lands that do not now produce tame hay crops, for lack of sufficient moisture; but as their value is as yet entirely problematical, they do not need to be enumerated here. Extensive investigations are now in progress, with a view to testing them for this purpose.

LARGE WATER-GRASS (*Paspalum dilatatum*) is one of the native grasses of the South that has recently attracted attention, particularly for pasture purposes. It is exceedingly well liked by stock, and furnishes

abundance of feed on medium to moist soils. The stems grow two and one-half to three feet high, but are not leafy enough to produce much hay. It is decidedly bunchy in habit, each clump producing a great mass of succulent root leaves which are greedily eaten by all classes of stock. Prof. S. M. Tracy, for many

FIG. 41—PLAT OF BLUESTEM IN THE GRASS-GARDEN AT WASHINGTON, D. C.

years director of the Mississippi Experiment Station, regards this as one of the valuable pasture-grasses of the South. Its seed has recently been made available in the markets.

GUINEA-GRASS (*Panicum maximum*) and Pará grass (*Panicum molle*) are two grasses that have attracted considerable attention in southern Florida in recent years. They are the standard grasses of the West Indies, where the green forage, particularly from guinea-grass, furnishes most of the roughage fed in

cities. It is brought to market fresh from the field on the backs of donkeys, and peddled about the streets. Pará grass is much used for pasture on the islands. In Florida neither of these grasses produce seed. They are propagated by cuttings, and the expense of securing a stand greatly reduces their usefulness. Most of the arable land of southern Florida is so valuable for trucking purposes that farmers cannot afford to grow grasses of any kind; but since these are the only ones yet found that thrive under the peculiar soil and climatic condition of the region, and since considerable feed is required for the farm stock, many attempts have been made to grow them. Grasses are particularly needed on the few dairy-farms to be found in that region. The amount of milk produced is far less than the demand, largely for the reason that dairymen are compelled to ship hay from the North. If practical methods of establishing these grasses can be worked out, it will render dairying a profitable industry there.

Prof. Frank S. Earle, of the Cuban Department of Agriculture, says, regarding these two grasses: "As to guinea-grass, it is the best pasture and hay grass in the world. I do not know how it will do in Florida sands, as I have seen it only in rich lands. It is usually planted by slips. I have never seen the seed, nor heard of its being planted. The Pará grass is not as nutritious as the guinea-grass, and it grows best in wet, half-swampy places. It is as hard to kill as Johnson grass, and I regard it as a rather bad weed. Still, like Johnson grass, it is a fine thing in its place, and yields enormously on lands that are too wet for anything else."

XIII

GRASSES FOR SPECIAL CONDITIONS

CATTERED over the country, in more or less extensive areas, are tracts of land that for one reason or another are not suitable for ordinary crops; yet, for some special reason, it may be desirable to utilize them. Such are the salt-marshes along the seaboard, inland swamps and overflowed lands, sandy lands that are liable to drift if left uncovered, lands too dry for ordinary crops, and the alkaline soils of the arid and semi-arid West. There are grasses more or less perfectly adapted to all of these unusual conditions, but, unfortunately, most of them are not amenable to cultivation. Most of them have such poor seed habits that it is impracticable to save their seed, and the best that can be done is to make use of them as they are found growing. Just why certain grasses should grow so abundantly without assistance, and yet fail to respond to man's efforts to propagate them, is not entirely clear. In most cases they are grasses which are adapted to a very narrow range of conditions. A very slight change in their environment seems to be sufficient to cause them to fail. In order to succeed with them we should have to learn their peculiarities better than we know them now. It is not surprising that we are ignorant of these little util-

ized grasses, for it takes the combined experience of many thousands of farmers to determine the peculiarities and adaptability of any new crop.

WET LANDS

Lands too wet for cultivation are frequently extremely fertile, and would be very productive if we could find grasses that could be started upon them merely by scattering the seed. There are many wild grasses, and a few tame ones, adapted to such soils. Some of these wild species produce excellent feed, and a careful study should be made of them with a view to learning how to propagate them by seed.

Where land, not otherwise inclined to be wet, is merely overflowed by running streams for a period of a few days at a time, it is usually not difficult to grow the ordinary grasses. Even alfalfa thrives under these conditions. But where the land is covered for long periods, and particularly where stagnant water remains for a considerable time, the problem is much more serious. Even the wild swamp-grasses will not stand prolonged submergence in stagnant water, particularly in warm weather. Many grasses will grow in shallow water, but none of any value can bear continued submergence of the whole plant. Timothy can be started on moderately wet soils merely by sowing the seed. On soils a little too wet for timothy, redtop and

Fowl-meadow grass (*Poa serotina*) can be started in the same manner. The latter grass is a very good one, but it is not much used, so that seed obtained in the markets is apt to be old or otherwise of poor quality. These two grasses, mixed with alsike clover,

make the best combination for wet or overflowed lands of any grasses whose seed can be had in the markets; but they are not adapted to very wet lands, such as remain muddy throughout the season. For such lands we have to depend at present on the chance growth of wild grasses. In the South barn-yard grass, already mentioned with the Japanese millets, grows on rather wet lands. Its seed is easily saved, and it is worth more attention than it has heretofore received in that section, particularly on lands subject to June overflow.

WILD RICE (*Zizania aquatica*) is a very large, succulent grass that grows even in shallow water, and furnishes excellent green feed for cattle when it can be harvested. A dairyman near Washington city annually cuts a large area of it for soiling purposes, and reports it to be excellent feed. Its seed furnishes valuable feed for fish and water-fowl. A few dealers offer seed of this grass.

LARGE WATER-GRASS (*Paspalum dilatatum*) is said to be a valuable grass on wet lands in the South. Its seed has recently been placed on the market. There are numerous other grasses, yielding feed of fair to good quality, growing on swampy land in all parts of the country, but those mentioned are the only ones of which seed is available at the present time.

SANDY LANDS

For drifting sands only one grass has thus far been successfully used—namely:

BEACH-GRASS (*Ammophila arenaria*).—This is the "Marram" grass of Australia. Extensive planta-

FIG. 42—SEASIDE BLUE-GRASS

tions of it have been made on our North Atlantic Coast and in Western Europe. It also thrives in the sands on the shores of the Great Lakes. It is propagated entirely from sets, not from seed. Of cultivated grasses, millet is adapted to rather sandy soils, and rye is an excellent winter crop for such lands; but these two crops are not adapted to the sandiest soils. Canada blue-grass (*Poa compressa*) possesses some advantages as a pasture or lawn grass where the soil is sandy.

In the South there are several good grasses for this purpose, the best being Bermuda grass, carpet-grass, and

ST. AUGUSTINE GRASS (*Stenotaphrum dimideatum*).—All three of these are propagated from cuttings or pieces of sod. St. Augustine grass occurs along the Atlantic Coast from Charleston, S. C., southward, but does not extend far inland. It is a popular lawn grass in that section. Numerous grasses are found growing on more or less sandy land in the West, but none of them have found their way into the markets.

VELVET-GRASS (*Holcus lanatus*), one of the oldest domesticated grasses in England, is, in the immediate vicinity of the Pacific Coast, a first-class meadow grass on soils that consist of nearly pure sand. It is discussed in a previous chapter.

SEASIDE BLUE-GRASS (*Poa macrantha*) (Fig. 42) is also found on the sands at the mouth of the Columbia River. This grass may be worth looking after. It produces an abundance of seed, which is easily harvested. Whether it has any value away from the coast is not known.

DRY LANDS

Some of the cultivated grasses are noted for drouth-resistance, and are of great value in regions of comparatively light rainfall. The most notable of these is brome-grass. In the South, Johnson grass is of some value as a drouth-resister, as is also Bermuda grass. These have already been discussed. There are many wild grasses that thrive in regions where the rainfall is too slight for farming, and several million acres of such grasses are annually cut for hay in the West. An enumeration of them would be out of place in a treatise on farm grasses.

ALKALI SOILS

All soils contain more or less soluble mineral matter. Soil consists mostly of small rock particles composed chiefly of quartz, but containing small quantities of numerous substances. As these rock particles disintegrate under the action of moisture, air, heat, and cold, small portions of soluble substances are set free in the soil. In humid climates these substances are washed out and carried off by streams to the ocean. This is the origin of the saltness of sea-water. This process has been going on ever since rain began to fall on the hot crust of the newly formed earth, and the ocean has thus become the storehouse of vast quantities of soluble material formerly constituting part of the rock and soil of the earth's surface.

In arid climates, where the rainfall is insufficient to saturate the soil down to the water-table below, and where most of the rain that falls is evaporated from the

surface, these soluble substances collect in the soil until the quantity becomes so great as to be detrimental to plant life. This produces alkali soils. Where these salts are abundant in the soil they tend to collect in low places, where most of the evaporation occurs. Irrigation frequently causes alkali to rise to the surface on soils where plants grew readily at first, but which soon became too salty from the evaporation of the salt-laden water.

Some species of plants have become adapted by nature to these strong alkali soils. Among cultivated crops there are varying degrees of resistance to alkali. Alfalfa will grow on rather strongly alkaline soils. Australian salt-bush thrives on decidedly strong alkali. Neither of these are, however, true grasses. None of the cultivated grasses is decidedly alkali loving, but several wild species of the West are not averse to it. The most useful of these are:

GIANT RYE-GRASS (*Elymus condensatus*).—This grass produces an abundance of good seed which could easily be saved if a demand were created for it. It grows in the wild state in large clumps, but when the seed is sown at the rate of 25 or 30 lbs. per acre it makes a uniform growth, and gives a large yield of coarse but palatable hay. The hay is said, by those who have fed it, to be very nutritious, but it contains salts enough to make it decidedly laxative. It is, therefore, better adapted for cows than for horses. Yet some farmers who have grown it for horse-feed speak highly of it. It deserves attention as a hay grass on soils too strongly alkaline for alfalfa. (A typical view on ranges of the West, showing

Elymus condensatus in low alkaline soil, is seen in Fig. 43.)

SALT-GRASS (*Distichlis maritima*), a small, sod-forming grass, grows on soils very strongly alkaline. Some forms of it grow tall enough to cut for hay. It

FIG. 43—TYPICAL VIEW ON RANGES OF THE WEST SHOWING BUNCHES OF GIANT RYE GRASS

is too salty for first-class feed, but stock eat it very readily when better feed is scarce. No attention has been given to its propagation. It is a shy seed-bearer, but a little attention from the plant-breeder could doubtless develop a strain of salt-grass of considerable value for soils too strongly alkaline for other grasses.

XIV

LAWNS AND LAWN-MAKING *

A WELL-MADE and well-kept piece of greensward is a beautiful and pleasing object, restful alike to the eye and body. It thus has both æsthetic and practical value, and justifies whatever expenditure its making and maintenance entail.

GRASSES FOR THE LAWN

In selecting the grass the lawn-maker will be limited to the fine-leaved, turf-forming species suited to his conditions of soil and climate. Adaptability is of more importance than color or texture, though these must be considered. There is usually more than one species adapted to any given conditions. The United States may be divided into three general sections, between which, however, no definite line can be drawn.

NORTHERN STATES

For all this section, extending from the Atlantic to the Pacific, with minor exceptions, Kentucky blue-grass is the standard for lawn-making. The exceptions are the Atlantic Coast, discussed below, and parts of the Great Plains region where rainfall is somewhat deficient. In this latter region buffalo-grass and Canada blue-grass should be carefully tried. Over most of the Northern States redtop and the other bent grasses

* By Carleton R. Ball, United States Department of Agriculture.

can also be used. They love moist, clayey, or loamy soils. In gravelly or sterile soils in the northern part, Canada blue-grass outranks its better-known relative.

ATLANTIC COAST

From Maine to Maryland and Virginia blue-grass does not thrive near the coast. The slight elevation, heavy rainfall, and moist clay soils do not seem adapted to its best development. Redtop and the bent grasses are here at their best. They supersede blue-grass in lower New England and at other points along the coast. Over part of this area the soil is normally somewhat acid, a condition apparently not harmful to species of *Agrostis*. At Washington, D. C., redtop is being used exclusively in new seeding on the Public Grounds.

SOUTHERN STATES

Bermuda grass is the standard lawn grass in most of this region. It has all the characters of a good lawn grass except that it is not resistant to frost. The first heavy frost of autumn changes it from a beautiful green to a light brown color, and thus it remains until late in the following spring. Scarifying the sward with the disk-harrow in the fall and sowing a winter grass, such as Italian rye-grass, has been recommended and has proved successful in some trials. St. Lucie grass, a variety of Bermuda, and St. Augustine grass, a coarser, creeping species of the Florida coast, are also used. Korean lawn-grass is similar to St. Augustine grass. All these are not frost resistant, or at best but little more so than Bermuda.

DESCRIPTION OF GRASSES

Bermuda grass (*Cynodon dactylon* (L.) Pers.). By its strongly creeping habit, resistance to heat, drouth, grazing, and trampling, and its adaptability to both sandy and clayey soil, this grass is of the greatest value for Southern lawns. The objections to it are that the foliage is not resistant to frost, though the plant does not winter-kill below the latitude of Washington and St. Louis. It is also hard to eradicate, and spreads readily from the lawn to adjacent fields and gardens. The objection to its being non-resistant to frost is in part overcome by sowing a winter grass with it each fall. The Bermuda sod is cut up with a disk-harrow, and the seed sown thereon. Italian rye-grass has been successfully used for this purpose. Bermuda grass can be started either from seed or cuttings. Eight to ten pounds of seed will be sufficient in well-prepared soil. The cuttings may be made by running clean turf through a fodder-cutter, or chopping it by hand, and planting the pieces in shallow furrows a foot or so apart. The land must be leveled after planting, or the use of the lawn-mower will be very difficult.

St. Lucie grass is a variety of Bermuda grass which is said not to root so deeply in the earth and to be slightly more resistant to frost. It is found in eastern Florida. St. Augustine grass (*Stenotaphrum dimidiatum*) is found along the southern Atlantic Coast from Maryland southward. In habit it is much like Bermuda grass, but is coarser, with broader leaves, and is more easily eradicated. It has been used for lawns to some extent in the Carolinas and Florida. Korean

lawn-grass (*Osterdamia matrella* (L.) Kuntze) is a common grass of the Orient, but not yet obtainable commercially. It is much like St. Augustine grass in character. Though slightly hardier than Bermuda, it is not frost resistant.

Carpet-grass (*Paspalum compressum* (Sw.) Nees) is a low, creeping species, resembling Bermuda in habit, apparently native to the Gulf Coast. It seems to thrive best on somewhat sandy lands where it is closely grazed and trampled. It flourishes in spite of heat and drouth, and holds washing soils well. For years it has been gradually extending its range northward in the Gulf States. Though the seed is not on the market, this grass should be tried for lawns in that section. Cuttings can be used for starting the sward, as in the case of Bermuda grass. It is much more resistant to frost than that species.

Canada blue-grass (*Poa compressa* L.) is of lower and more wiry growth than Kentucky blue-grass and also darker in color. Although an introduced grass, it is now found quite abundantly in the States about the Great Lakes. On rather dry, gravelly, or somewhat sterile soils it is more successful than Kentucky blue-grass, and should be used in such situations. It has given good results in parts of the Plains region west of the Missouri River, where rainfall is light.

Fescues (*Festuca* spp.). There are several species or varieties of the fine-leaved fescues, which are of considerable value for lawn-making in shaded places or on poor or gravelly hillside soils. Among them are: *Festuca australis*, hard fescue (*F. duriuscula*), various-leaved fescue (*F. heterophylla*), sheep's fescue (*ovina*),

red fescue (*F. rubra*), and fine-leaved fescue (*F. tenuifolia*). Most of these, except red fescue, are probably forms of sheep's fescue. Various-leaved fescue and hard fescue are recommended for shady lawns. All have fine, needle-like leaves, which need but little cutting, as their growth is slow and they reach but a few inches in hight. Most of them are bunchy in habit, and must be sown thickly to form a turf.

Italian rye-grass (*Lolium italicum* L.). This is not a true lawn grass, but is often used in mixtures because of its hardiness and very rapid growth, which enable it to quickly cover bare ground with a pleasing coat of green. It is short-lived, and will be seen but little after the second year.

Kentucky blue-grass (*Poa pratensis* L.). This is the king of lawn grasses for the greater part of this country, and is held to be the standard of color and quality of turf. From the Atlantic to the Pacific, except in the extreme South, it is successfully grown with uniform and pleasing results. To the low moist clays of the immediate Atlantic Coast it is not as well adapted as redtop or creeping bent, and at lower altitudes than the Piedmont region of the South it must give way to Bermuda grass or other creeping species. Blue-grass does not reach its best development in the first year from seed, but gradually produces a splendid and durable sward. It does not do well in heavy shade, but is suitable for parks and partly shaded areas. It is not adapted to acid soils, but prefers those of limestone origin.

Rough-stalked meadow-grass (*Poa trivialis* L.) and wood meadow-grass (*Poa nemoralis* L.) are two species

closely related to Kentucky blue-grass. The latter closely resembles it, but the former is a lighter green in color, and the leaves are more shining. Both are adapted to use in shaded situations in the sections where blue-grass and redtop are used. They can also be used farther south because protected from the heat by the shade under which they grow.

Redtop (*Agrostis alba* L.). This is one of our best-known grasses, and, though rather coarse in foliage, lends itself well to lawn-making. It forms a close, durable sward, soft in texture where mowed frequently to induce the production of fine foliage. Neither cold nor heat are specially injurious to it, but moist, clayey soils are preferred. In the region of Lakes Erie and Ontario and in the upper Atlantic Coast redtop is largely used, both in mixtures and alone. It forms a large percentage in practically all the lawn-grass mixtures sold in this country, and on the whole is one of the best grasses for the purpose. It has a special field in the moist and somewhat acid soils of the lower New England States and the northern Atlantic Coast, where blue-grass does not thrive.

Two similar and closely related species are creeping bent (*Agrostis stolonifera*) and Rhode Island bent (*A. canina*). The former is regarded as a variety of redtop, but is much finer in habit and foliage, and produces the softest and most velvety turf of any grass in this country. Rhode Island bent is intermediate in habit and texture between the other two. All are adapted to the same conditions of soil and climate. Rhode Island bent is largely used in Rhode Island and Connecticut, where practically all the seed is grown.

MAKING THE LAWN

The greatest of care is necessary in preparing the seed-bed. The ideal condition for the successful growing of fine lawn grass is a deep, rich, friable, loamy soil. Too much emphasis can not be laid on the importance of good soil and thorough preparation. Deep plowing of larger areas and deep spading or trenching of small plats is required to a depth of at least ten or twelve inches. Where the fertile surface soil is but a few inches in depth it should be turned so as to leave the good soil still at the surface.

While the plowing or spading is being done is the time to enrich the land for years of future productiveness. Well rotted barnyard manure, free from weeds and in good condition for mixing with the soil, is probably the best fertilizer that can be used. It is often difficult to obtain manure of this quality. Where used its fertilizing effect may be increased and prolonged by adding also some commercial fertilizers. In preparing land for a lawn, manure may profitably be applied at the rate of from thirty to fifty tons per acre. It is desirable to add phosphoric acid and potash in larger quantities than are supplied by the manure. Using bone meal at the rate of from three hundred to six hundred pounds per acre, or superphosphate of lime, commonly called acid phosphate, in smaller quantities, will supply the needed phosphoric acid.

Potash may be had in the form of wood ashes, which should be applied at the rate of five to ten tons per acre. Ashes contain also much lime, which is helpful to the growth of clovers and most of the grasses, except the

bent grasses. Kainit may also be used as a source of potash. These fertilizers must be thoroughly worked into the soil while the ground is being prepared. Seed should not be sown for ten days or more after the application of strong commercial fertilizers in large quantities, as the delicate seedlings are apt to be injured thereby.

After thorough working and fertilizing, the surfaces of the seed-bed must be put into exceedingly fine tilth for the reception of the seed. This is accomplished by the aid of the acme and smoothing harrows, or, on small areas, the hand-rake and the roller. No effort should be spared to bring the surface to the desired tilth. A recent invention, the disk smoothing harrow, has proven very well adapted to the purpose. If the ground has been very deeply worked it may be well to let it settle a day or two before the final preparation of the surface.

SEED AND SEEDING

Only the best quality of seed should be used. It may cost much more than the cheaper grades, but is least expensive in the end. Cheap grades contain large quantities of chaff and other inert matter, as well as the seeds of many kinds of noxious weeds. By actual weight weed seeds constitute from one to three per cent. of the average lawn grass-seed, while chaff makes up from twenty to fifty per cent., and even more. This inert matter does no harm when sown, but is expensive at the price paid for it as seed.

The weight per bushel of the commercial grass-seeds varies with their quality. The standard or legal

weight of blue-grass and redtop has been 14 lbs. in most States. This standard was established when it was impossible to clean grass-seed. Ordinary grades are now quoted at from 14 to 20 lbs., and fancy or extra fancy seed at 20 to 36 and even 40 lbs. per bushel. These differences are due almost entirely to variations in the amount of chaff present.

The most important factors affecting the rate of seeding of lawn grasses are the quality of the seed, the time of year, the condition of the soil, and the purpose for which sown. From two to four bushels of seed are commonly recommended. Three or four bushels of good seed, weighing at least 25 lbs. to the bushel, is the proper amount to sow. Four bushels per acre is at the rate of four-fifths of a quart per square rod, or one quart to 340 square feet of surface, which equals an area 17 by 20 feet. By weight it is 10 ounces per square rod, or one pound to 436 square feet, which equals approximately an area 20 by 22 feet. If 20 lbs. to the bushel is taken as an average weight, and the seed be sown at the rate of four bushels per acre, it requires a half pound per square rod, or one pound on 500 square feet of land, which is an area 20 by 25 feet. Quality of the seed as regards purity and vitality must, after all, control the amount sown. Seed containing much chaff and of low germinating power should be sown at the rate of six bushels per acre. Where the weight is 30 to 35 lbs. per bushel, and the percentage of germinable seed is high, the amount need not be over three bushels. Intermediate grades should be sown in proportion.

In late spring or late fall sow more heavily than in

more favorable seasons. Midsummer sowings should be especially heavy. For lawns, sandy soils will require heavier seeding than loamy ones, dry soils more than moist ones, sterile soils more than fertile ones, on account of the low germination under these conditions, and rough land more than land in perfect tilth. Areas which are to be subject to rougher and more constant usage require heavier seeding and also special kinds of grasses. In general, small plats should receive proportionately more seed than larger areas. As a rule, heavy seeding will be well repaid in all lawn formation.

The seed may be sown either by hand or with the grass-seeding attachment on a grain drill, or with a wheelbarrow seeder. If the area is large the use of a machine is decidedly preferable. The wheelbarrow seeder, though run by hand-power, will sow faster than a drill. The seed is also likely to be more evenly distributed with the machine than by hand unless the sower has had much experience. A time should be chosen when but little air is stirring. With either hand or machine seeding it is best to go over the land twice, the second time at right angles to the first, in order to avoid leaving unsown spots. White clover-seed may be mixed with the grass-seed before sowing, and if a mixture of grass-seeds is used it should be made by thoroughly mixing the seed in some large vessel and all the kinds sown at once.

As soon as sown the seed should be immediately covered. This may be done either with the iron rake or the roller, or both. If the rake is used it must be done very lightly, as small grass-seeds will not germi-

nate if covered to any considerable depth. An eighth of an inch is an ideal depth, and one-fourth inch as deep as is at all safe. The careful use of the roller will press all the seed into the soil, and at the same time it firms the surface soil in a very helpful way. On small plats a light mulch of rotten leaf mold or similar substance will protect from birds and prevent the drying of the surface soil. If it is necessary to water to promote germination this should be done with great care, imitating a gentle rain as much as possible. At the same time it is well to fully soak the ground, so that no more water may be necessary till the grass is well up and out of danger of injury.

Grass-seeds may be sown at almost any time of the year. The early spring and early fall months are decidedly preferable, however. Most of our lawn grasses —at least, those used in the Northern States—are adapted to cool climates, and make their best growth in cool weather. Spring sowing should be done as early as possible, so that the grass may become firmly established before hot weather sets in. Fall sowing should be done in the latter part of August or in September. Grasses started then will be well set before winter. Seeds sown late in October will generally not germinate that fall, but if conditions are favorable will remain in the ground over winter and start very early the following spring. Unless a quick cover crop is needed to prevent washing of the land or for the green appearance, no nurse crop should be used with grass-seed. Grasses seldom need any protection, and are often injured by the shading and smothering of the more vigorous nurse crop.

TURF AND TURFING

Where a good quality of turf can be secured it is often advisable to use turf in covering small plats. It should be cut in strips ten inches or more in width and about two or three feet long. These should be laid on a level bed of good soil, and carefully packed down and the joints evenly matched. If, on drying, cracks are formed between the sods, these must be filled with pure earth. Seed may be sown in them if desired. Freshly laid turf must be kept well watered while the new roots are starting and a compact sward is being formed. Turfing is not recommended, however, because of the great difficulty of securing turf of desirable grasses free from weeds and weed-seeds.

MOWING

Much of the beauty and health of a grass sward will depend on frequent and regular mowing during the growing months. Once a week will be often enough to mow the average lawn, though when the grass is in the period of most vigorous growth it may be necessary to mow oftener. Mowing every three or four days will not injure the grass in any way if a short, firm sward is desired. Young grass may be allowed to reach a hight of five inches before being mowed at all, and the work should then be done with a scythe rather than a lawn-mower. During hot weather the grass on a thin sward should not be mown so closely as to permit the drying out of the surface and injury to the grass roots. Where the stand is thin it is well to allow the cut grass to remain on the ground, especially in hot weather,

when it forms a very useful mulch. In general, however, it should be removed after each cutting. At the end of autumn the grass should be allowed to grow

FIG. 44—GREENSWARD IN PUBLIC GARDENS, BOSTON, MASS.
(Lamson-Scribner in Year-book of United States Department of Agriculture for 1897.)

taller and should be left uncut, so that it may hold the snow better and thus be protected during the winter.

Views of well-kept lawns are presented in figures 44 and 45.

WATERING

Lawns, in order to be kept fresh and green, require ordinarily a great deal of water. While water must, therefore, be used liberally, it must be applied with care. Sprinkling should be done either in the early

morning or in the evening, after the heat of the day has passed. The small plats of turf about city houses suffer severely from being watered late in the morning,

FIG. 45—LAWN-MOWERS, OR TURF-MAKERS, IN DRUID HILL PARK, BALTIMORE, MD.

(Lamson-Scribner in Year book of United States Department of Agriculture for 1897.)

and the wet grass then subjected to the full heat of the summer sun, intensified by the surrounding walks and buildings. A proper sprinkling nozzle should also be used on the hose. When this is not done the turf may be greatly injured. Where the full force of the stream is allowed to strike directly against the surface of a thin sward, the soil is washed slowly from the roots of the grasses and they are thus exposed to the sun

and killed. This is especially true on terraces and banks where the earth is more easily disturbed, and where the sun's heat falls more vertically at times. It is better to water heavily, soaking the ground to a depth of a foot or two, than to apply water in small amounts and more frequently. On all but the smallest plats a sprinkler of the fountain or revolving type can be advantageously used. These save a great deal of time and labor in applying the water, but care must be taken that corners and other small spaces are not left without water.

ROLLING

Next to the mower the roller is a most important implement. It should be used in early spring to firm the sward after the heaving of the soil due to freezing and thawing in winter. After heavy rains during summer and autumn, and on young swards as soon as they can bear it, the roller should be used. Those made in two or more sections are preferred, because they turn with less injury to the soil and sward. The most good will be done by the roller weighing at least fifteen pounds to the inch of length. One is now for sale which may be increased in weight at will by filling a hollow compartment with sand or water.

FERTILIZING OR TOP-DRESSING

No matter how thorough the preparation, the lawn will eventually demand a new supply of food. This must be given in the form of natural or artificial fertilizer. Well-rotted barnyard manure is unexcelled for this purpose. It may be applied in the fall and

allowed to remain through the winter, raking off all straw and trash remaining in the spring when growth starts. Or it may be applied very early in the spring, just in time to be dissolved and carried into the ground by the heavy spring rains. In either case nothing coarse should be left on the ground when the grass begins its growth. Commercial fertilizers, such as ground bone or bone meal, dried blood, and nitrate of soda, may also be used. From 200 to 500 lbs. may be used at a single time. It is necessary to apply them just before the beginning of a rain or to wash them into the soil with the hose when a large quantity is used, in order to prevent burning the grass. They should never be applied to the grass while wet from dew or rain, as the grass leaves may be severely burned by the chemical ingredients, unless the fertilizer is quickly washed in by the addition of more water. Nitrate of soda is adapted for rapid forcing of the grass, and the effect is soon spent. The others are slower and more lasting in their action.

WEEDING

It is not possible to do more than mention the subject of weeding here. No effort should be spared to keep the grass free from weeds. They impair the beauty and usefulness of the sward, and even threaten its very life by their rapid and vigorous growth. Annual weeds should be kept carefully mowed ; if no seed are allowed to ripen, they will soon disappear. If they spread rapidly and smother the sward as does crabgrass, they should be uprooted if possible. Perennials, as dandelion, plantains, and similar weeds should be

carefully dug out and destroyed. On no account allow them to produce and scatter their seed. A few drops of some strong acid, such as sulphuric or carbolic, applied to the cut root will help in destroying them. Places left bare by their removal should be raked over and resown in grass to prevent other weed seeds from finding lodgment there.

RENOVATION

Eternal vigilance is the price of a perfect sward. Wherever a break occurs in the turf covering it should be at once repaired. An iron rake will prepare the spot for seeding, and with a little seed and a gentle watering the new growth of grass may be started. The seeding of such spots should be heavy, for the ground can rarely be more than scratched with the rake instead of thoroughly worked up, and much of the seed will never develop sturdy plants. Thin places in the turf may be treated in the same manner without danger of injury to the grass already growing ; in fact, it is often perceptibly benefited by such treatment. Its growth helps to protect the new grass while starting. Renovated spots should be fertilized well to encourage rapid growth. Care must be taken that the same kind of seed is always used, or the result will be a ragged or patchy sward of very unpleasing appearance.

XV

MISCELLANY

GRADES OF HAY

THE grades of hay adopted by the National Hay Association in 1902 are given below. These grades have been adopted by the Boards of Trade in the following important markets:

Chicago, Ill.	Columbus, O.
St. Louis, Mo.	Louisville, Ky.
Kansas City, Mo.	Philadelphia, Pa.
Indianapolis, Ind.	New York, N. Y.
Brooklyn, N. Y.	Pittsburg, Pa.
St. Paul, Minn.	Buffalo, N. Y.
Toledo, O.	Washington, D. C.
Cincinnati, O.	Richmond, Va.
Cleveland, O.	New Orleans, La.
Baltimore, Md.	Norfolk, Va.

They are also adhered to in practically all the smaller centres tributary to these larger cities.

GRADES OF HAY AND STRAW

Choice Timothy Hay.—Shall be timothy not mixed with over one-twentieth other grasses, properly cured, bright, natural color, sound, and well baled.

No. 1, Timothy Hay.—Shall be timothy not more than one-eigth mixed with clover or other tame grasses, properly cured, good color, sound, and well baled.

No 2, Timothy Hay.—Shall be timothy not good enough for No. 1, not over one-fourth mixed with clover or tame grasses, fair color, sound, and well baled.

No. 3, Timothy Hay.—Shall include all hay not good enough for other grades, sound, and well baled.

No. 1, Clover-mixed Hay.—Shall be timothy and clover mixed, with at least one-half timothy, good color, sound, and well baled.

No. 2, Clover-mixed Hay.—Shall be timothy and clover mixed, with at least one-third timothy, reasonably sound, and well baled.

No. 1, Clover Hay.—Shall be medium clover, not over one-twentieth other grasses, properly cured, sound, and well baled.

No. 2, Clover Hay.—Shall be clover, sound, well baled, not good enough for No. 1.

No Grade Hay.—Shall include all hay badly cured, threshed, badly stained, or otherwise unsound.

Choice Prairie Hay.—Shall be upland hay, of bright color, well cured, sweet, sound, and reasonably free from weeds.

No. 1, Prairie Hay.—Shall be upland, and may contain one-quarter midland of good color, well cured, sweet, sound, and reasonably free from weeds.

No. 2, Prairie Hay.— Shall be upland of fair color, or midland of good color, well cured, sweet, sound, and reasonably free from weeds.

No. 3, Prairie Hay.—Shall be midland of fair color, or slough of fair color, well cured, sound, and reasonably free from weeds.

No. 4, Prairie Hay.—Shall include all hay not good enough for other grades, and not caked.

No Grade Prairie Hay.—Shall include all hay not good enough for other grades.

STRAW

No. 1, Straight Rye Straw.—Shall be in large bales, clean, bright, long rye straw, pressed in bundles, sound, and well baled.

No. 2, Straight Rye Straw.—Shall be in large bales, long rye straw, pressed in bundles, sound, and well baled, not good enough for No. 1.

No. 1, Tangled Rye Straw.—Shall be reasonably clean rye straw, good color, sound, and well baled.

No. 2, Tangled Rye Straw.—Shall be reasonably clean, may be some stained, but not good enough for No. 1.

No. 1, Wheat Straw.—Shall be reasonably clean wheat straw, sound, and well baled.

No. 2, Wheat Straw.—Shall be reasonably clean, may be some stained, but not good enough for No. 1.

No. 1, Oat Straw.—Shall be reasonably clean oat straw, sound, and well baled.

No. 2, Oat Straw.—Shall be reasonably clean, may be some stained, but not good enough for No. 1.

In the Mountain States and on the Pacific Coast several other grades are recognized on the markets, the principal being the various grades of alfalfa and grain hay. The latter usually consists of wheat, or a mixture of wheat and wild oats. Bluestem has a separate rating in a few localities. It is interesting to note

that the hay which ranks highest on the Denver markets, and known locally as South Park Hay, is neither a grass nor a legume, but a sedge (*Juncus balticus*). It grows on over-irrigated meadows in South Park, Colorado, and in similar situations in other parts of that State and Wyoming. Horses prefer it to any other hay, and feeders consider it the acme of fine hay for driving-horses. It is strictly a wild hay, cut from volunteer growth on meadows that are irrigated too heavily to permit tame grasses to grow.

The amount of low-grade hay that reaches the markets is surprising to those not familiar with market conditions. Leaving meadows down till they become weed-infested accounts largely for this cheap hay. The importance of renewing meadows before they become weedy has already been dwelt on at some length. An incident on one of the large hay markets, recently witnessed by the writer, enforces this point. A commission merchant had that morning received two carloads of hay, one of first-class quality, and one badly mixed with weeds and volunteer grasses. The car of good hay sold immediately at a good price. The other car was passed by a dozen buyers, and finally sold for just two-thirds the price of the other. There were some fifty cars of low-grade hay on the same market and no one wanted them, but there was a string of buyers hunting for hay of good quality.

MEASURING HAY IN THE STACK

Lack of facilities for weighing hay on many farms renders it necessary frequently to resort to measurements of the stack as the only means of getting the

weight. Frequent inquiries come to the Department of Agriculture for the "government rule" for ascertaining the weight of hay from measurements. There is no such rule adopted by any branch of the government service, so far as the writer has been able to learn. So far as known, only one State (New Mexico) has a law governing the case. According to this law the number of cubic feet in a rick is determined thus: Multiply the width by the over;* divide the product by four, and multiply the quotient by the length.

This rule is not satisfactory. It is fairly accurate for very narrow-topped ricks that are about three-quarters as high as wide; but for tall ricks, with well-rounded tops, it gives results nearly 30 per cent. too low. Another rule, recently published in a Western farm paper, is as follows: Subtract the width from the over; divide by two, and multiply by the width and then by the length. This rule is fairly accurate for tall ricks (as tall as wide or taller) with narrow to very narrow tops; but for low, rounded ricks it gives results about 15 per cent. too low. The writer has devised the following rule, which gives very accurate results for ricks of any form. The greatest error is in the case of ricks one-quarter taller than wide, or more, and very narrow at top. Even for ricks of this shape the error is less than 5 per cent.

RULE FOR MEASURING RICKS

Subtract the width from the over; divide by the hight; then multiply successively by the over, the width, the length, and by .225.

* The "over" is the distance from the ground on one side over the rick to the ground on the other side.

The results obtained by applying all these rules to two ricks of different form are given below.

	Rick A	*Rick B*
Hight (ft.)	9.0	12.0
Width (ft.)	12.0	12.1
Over (ft.)	23.88	28.2
Volume—true (cubic ft.)	2,534.4	3,084.0
Volume—First rule (cubic ft.)	2,149.2	2,559.1
Volume—Second rule (cubic ft.)	2,138.4	2,922.1
Volume—Third rule (cubic ft.)	2,553.0	3,087.0
PER CENT. OF ERROR		
First rule	14.0	17.0
Second rule	15.6	5.2
Third rule	.7	.1

These two ricks were measured with the utmost care. It will be noticed that *A* is three-quarters as tall as wide; it was also quite round. *B* is as tall as wide, and narrow topped—a very common form. The rule last given is seen to give very accurate results in both cases, while the other two give values much too small. In both cases the New Mexico rule gives large errors, the error being in favor of the buyer. The second rule gives a value much too small in the case of the low, round rick, but is more nearly corect for the tall, sharp-topped one.

No satisfactory rule for finding the volume of a round stack has yet been published, and the writer has not had time to develop one in his own investigations. The volume of such a stack may be found in the following manner, which, however, is too tedious to be practicable: Measure the circumference of the stack at each foot of its hight. Square each of the numbers

thus obtained, add the squares together, and divide by 12.5.

NUMBER OF CUBIC FEET PER TON

So far as the writer is able to ascertain, the number of cubic feet of hay in a ton has been investigated very little. He is now measuring the volume of a large number of ricks, stacks, and mows, the hay from which is to be baled. It is hoped that these data may furnish a basis for determining the volume of a ton of hay with some degree of accuracy. Until the weight corresponding to the volumes measured are known, no reliable figures can be given. The problem is so complex that no such satisfactory rule for estimating the number of cubic feet in a ton may be found as is given above for finding the volume of a rick of hay.

The volume of a ton of hay depends on several factors. A stack that has stood four months is much denser than one freshly built. Hence the length of time a stack has stood determines, to some extent, the number of cubic feet in a ton of the hay. Also a tall stack settles more than a low one. The kind of hay also has much to do with it. Clover hay is lighter than timothy, volume for volume, and hay with stiff weed stems in it does not settle down as compactly as hay with no weeds in it. It is common to consider 512 cubic feet (an 8-foot cube) as a ton in hay stacked only a few days, while 350 to 380 cubic feet of hay that has stood two months or more will usually make a ton. In developing rules for estimating the number of cubic feet in a ton of hay, the points to be determined are (1) the rate at which hay settles after stack-

ing; (2) the relation of the hight of the stack to the rate of settling; (3) the influence of the kind of hay and its condition as to dryness when stacked on the number of cubic feet in a ton. Whether the results will be of much value will depend on whether the influence of these various factors can be reduced to rule. For the present the figures for the number of cubic feet in a ton given in the New Mexico law may be used provisionally, unless more accurate ones are known. They are: 512 cubic feet for the first twenty days, 422 from the twentieth to the sixtieth day, and 380 thereafter.

SEED HABITS

The amount of seed which can be harvested depends largely on the seed habits of the plant. Many otherwise excellent grasses are rendered useless by yielding very little seed, or seed which lacks vitality, or falls out too soon when ripe to be easily harvested. No grass excels timothy in good seed habits. In the amount of seed produced and the ease with which it is saved and cleaned, timothy has no rival among the true grasses. This fact probably accounts, in large measure, for the popularity of this grass with American farmers. Not that it yields so many more pounds of seed per acre than other grasses, but, its seed being small, an acre of timothy will produce seed enough to sow a larger area than is the case with any other grass grown in this country. An example of poor seed habits, and the resulting uselessness of a grass, is seen in reed canary-grass (*Phalaris arundinacea*). It grows wild over nearly all the northern half of this country,

and is greedily eaten by all classes of stock. Yet reed canary-grass is practically unknown to American farmers because of its exceedingly poor seed habits. Its seed falls almost the moment it is mature, and it is very difficult to get a stand from apparently good seed. Certain strains of this grass, however, hold the seed fairly well, and there is an opportunity for the plant breeder to add a valuable grass to the limited list of good American farm grasses by producing a strain of reed canary-grass with good seed habits.

Bermuda grass, the best pasture-grass in the South, and one of the best in the world, as stated elsewhere in this volume, does not produce seed in this country, except in parts of Florida, Arizona, and Southern California. In one respect this is an important advantage, because Bermuda, like Johnson grass, is very tenacious of life, and, when once established, is decidedly difficult to eradicate, unless one thoroughly knows how to go about it. It is, perhaps, fortunate under the circumstances that it has such poor seed habits. On the other hand, the seed is small and lacking in vitality, so that even when the seed is available, it is seldom possible to get a perfect stand from it, and it is, therefore, usually propagated from pieces of sod.

Some grasses propagate so readily from the seed as to render them a menace to the farmer. Crab-grass and Johnson grass belong to this class. If Johnson grass had the seed habits of Bermuda grass, it would not be the great pest it is, for, although its root-stocks are very tenacious of life, it spreads mostly from the seed. Most of our otherwise valuable wild grasses are not adapted to cultivation because of poor seed habits.

IMPROVING THE GRASSES

When we consider that the present improved and highly specialized breeds of live stock have nearly all been produced within the past century and a half from stock no better than the veriest scrubs that now roam the woods in sections where no effort to improve them has been made, and especially when by far the larger part of the improvement of any one breed has been made by a very few men working without the knowledge of any laws of breeding to aid them, it is not surprising that similar efforts should be made to improve the character of farm crops. Indeed, it is rather surprising that the effort did not become general long ago. But there are special difficulties in the way of improving crops that do not exist in the case of live stock. Improvement of animals has been brought about by dealing with them as individuals. On account of the small size of individual plants, particularly the grasses, it is a tedious task to study individuals. Most of the improvement of animals has been brought about mainly by eliminating inferior members of the breeding herd. A few stockmen of signal ability have followed another course. They have become so thoroughly familiar with animal form and character that they have been able to create for themselves mental pictures of ideally perfect animals, and they have searched through a whole breed for individuals approaching this ideal. When such an individual is found it is acquired at any cost, and herds of these nearly ideal animals have been built up. The most rapid progress in the improvement of breeds generally is traceable to these few herds.

It is only recently that a similar effort has been made to improve field crops. In most cases the work of breeding plants requires more technical knowledge than most men possess. It is tedious work at best, and requires much training and skill to cross-pollinate the ordinary field crops or, to select out the best plants in a field, or even in a small plat. It is natural that most progress should have been made with corn, for here the individual plants are of considerable size. As soon as farmers and plant breeders began to study the corn plant with a view to producing superior strains of the various varieties, marked improvements in seed corn began to be made. There are now many farmers who, by the aid received from careful students of the subject in our agricultural colleges, produce annually large quantities of pedigreed corn of a quality much superior in every way to the common corn varieties of the country. One breeder, who last year produced and sold 25,000 bushels of highly improved seed corn, estimates that those who planted this seed secured an average increase of eight to ten bushels per acre over seed of unimproved varieties. This estimate is based on reports furnished by farmers who used this seed. It should be remembered that this improvement has been brought about in a few years. When it has been in progress as long as has the improvement of live stock, we shall doubtless have breeds of corn as much superior to the common kinds as the present 2,000-pound bullock is to the 500-pound Smithfield show animal of a little more than a century ago.

Wheat has received considerable attention from the

plant breeder in recent years. Breeders have pursued two distinct courses with this crop. One set of breeders has been producing new varieties by crossing old ones. Thus far there has not been a great deal accomplished in this direction. It is only about three years since we first learned how to handle the apparently variable progeny of such a cross. A few varities have been produced that possess special qualities of more or less value. Now that we know how to get all the possible new varieties out of a cross, and can even tell in advance what most of these varieties will be like, much more ought to be accomplished in this line of plant improvement.

The other line of work with wheat has consisted in a careful study of a large number of individual plants in order to be able to save seed from the best. Prof. W. M. Hayes, of the Minnesota station, has done some excellent work of this kind, and has produced pedigreed strains of some of the standard varieties of that section that considerably outyield the original varieties.

Very little work of this kind has been undertaken with the standard hay and pasture grasses, but enough has been done to show valuable results. It has been shown that, in the crops that have been carefully studied, each kind of grass, as ordinarily sown by the farmer, consists in reality of a number of more or less distinct varieties mixed together. With the usual methods of securing grass-seed there is no opportunity to separate these varieties. In order to accomplish this, a careful study of the crop must be made until the grower is able to recognize the varieties of which it consists. This has been done in a few cases.

Dr. A. D. Hopkins, at present connected with the Bureau of Entomology of the Department of Agriculture, but formerly of the West Virginia Experiment Station, for many years grew timothy for seed. For this purpose the crop is ordinarily sown thinly, so that, during the first harvest year, the plants are sufficiently distinct to permit of the observation of individual plants. Many years' close observation showed that the crop consists of a large number of constantly recurring forms quite easily distinguished. A number of plants, each representing one of these forms, were taken up and separated into as many parts as the nature of the case permitted; in this way each plant became the parent, by division, of a large number of plants, all set side by side in a plat. When seed was harvested from these plats it was found that the plants produced from these seeds reproduced faithfully the characters of the original selection. Each original selection, therefore, became the parent of a variety. Several of these varieties are now growing in the grass-garden of the Department of Agriculture, where they have been the object of careful observation. They differ markedly in character of growth, earliness, size, etc. Some of them are evidently far superior to the ordinary timothy as grown by farmers (which is a mixture of superior and inferior varieties), some for seed production, others as hay plants, and others as pasture plants. (Some of Dr. Hopkin's varieties of timothy exhibited at the Paris Exposition are shown in Figs. 46 and 47.)

In a manner exactly similar, Mr. A. B. Leckenby, Director of the Eastern Oregon Experiment Station,

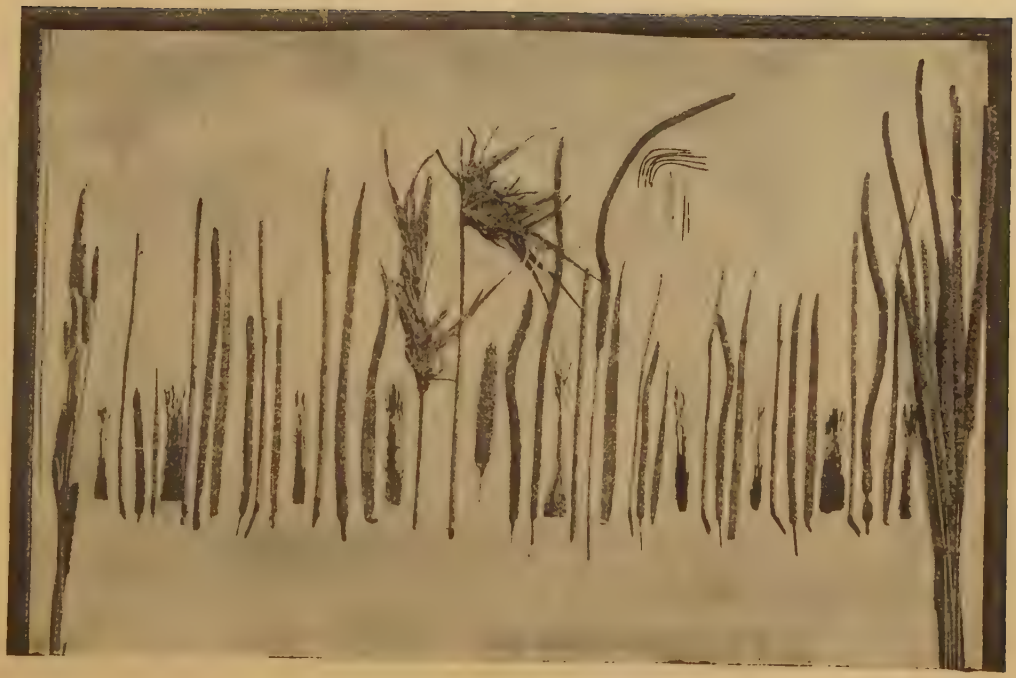

FIG. 46—VARIETIES OF TIMOTHY
(Exhibited at the Paris Exposition by Dr. A. D. Hopkins)

FIG. 47—VARIETIES OF TIMOTHY
(Exhibited at the Paris Exposition by Dr. A. D. Hopkins)

has isolated twenty-two varieties of brome-grass (*Bromus inermis* Leyss.) as distinct, for instance, in their agricultural characters, as the ordinary varieties of wheat (see Fig. 48). He has also isolated a larger number of varieties of blue-grass (*Poa pratensis*), differing to a remarkable degree in character of growth, and, consequently, in agricultural value.

It is probable that all the standard grasses can likewise be separated into varieties, some of which would be a marked improvement over these grasses as ordinarily grown. Much work of this character is now in progress, and it will be only a few years till farmers may be supplied with improved varieties of most of the important grass crops.

GRASS FADS

A word of caution to farmers concerning much-advertised new grasses may not be out of place, though, unfortunately, those who most need this caution will never see these pages. Every few years some enterprising seedsman discovers a new forage plant that, to quote from the seedsman's catalogue, "produces eighty tons of green feed per acre, is indestructible both by fire and water, and furnishes shade in summer and shelter against the storms of winter." Unfortunately, thousands of farmers have spent their hard-earned dollars for these much-advertised seeds at prices that amaze those who are familiar with their actual market value, only to learn that they are worthless weeds, or some old and well-known forage plant that is masquerading under a new name.

The two most prominent fads of this kind in recent

Photo, by A. D. Lacher.

FIG. 48—IMPROVED VARIETIES OF BROME-GRASS

years were sachaline, a well-nigh worthless representative of the smartweed family, and penicillaria (Fig. 49), which proved to be only pearl millet under another name. Many other instances might be mentioned. These new crops soon find their place in agriculture. Some of them have turned out to have considerable value in certain sections of the country. Brome-grass (*Bromus inermis*) is a case in point. This grass began to be widely advertised about ten years ago in this country. It has turned out to be a valuable pasture grass in the Prairie States, and may in time win a place in all the Northern States, but it is absolutely worthless south of Missouri and Kentucky. For several years past Turkestan alfalfa has been the most prominent fad with farmers. It has not yet found its place in American agriculture, but will undoubtedly do so in the near future, for the State experiment stations and the Department of Agriculture are giving it a thorough trial all over the country.

Farmers will find it to their advantage to wait till these trials are finished. Experiments are costly. Individual farmers can usually avoid such expense by leaving this work to those whose business it is to conduct experiments. Exorbitant claims for any new crop should be viewed with suspicion. Much useless expense would be saved to farmers by writing to the better class of agricultural journals, the experiment stations, and the National Department of Agriculture for information concerning any new and much-advertised crop, for these authorities are usually in possession of all the reliable information to be had concerning such things.

FIG. 49—PENICILLARIA, OR PEARL MILLET

THE GRASS FLOWER

The seed-head of the true grasses is of two general patterns. One is seen in the head of wheat, barley, timothy, etc. This form of seed-head is called a *spike* (see Fig. 50). Examination of a head of wheat shows that it consists of a number of "meshes" arranged in two rows on opposite sides of a central stem. These meshes consist of from three to five flowers each, arranged in a compact cluster called a *spikelet* (Fig. 51). In the timothy head the spikelets are not arranged in two opposite rows, but are scattered over an enlarged continuation of the stem.

A very different pattern of seed-head is found in oats, Kentucky blue-grass, and the like. The flowers of these are grouped in spikelets, but the spikelets are not arranged on a single stem. They are found at the tips of the many branches of the stem. This much-branched form of seed-head is called a *panicle* (Fig. 52).

Let us now examine more closely one of the small spikelets found at the tip of a branch of a blue-grass panicle. Fig. 51 shows one of these spikelets very much enlarged. Apparently it consists of seven parts very much alike. In reality the two lower divisions are merely two empty chaff-like leaves. The remaining five parts are complete flowers, having enclosed within each the organs that are seen in the expanded flower shown in Fig. 53. The names of these parts of a spikelet are shown in Fig. 51. The flowers of the true grasses are called florets.

The parts of a single floret are well shown in Fig. 53. First, there is the leaf-like floral glume, very much like the empty glume at the base of the spikelet.

FIG. 50—A SPIKE

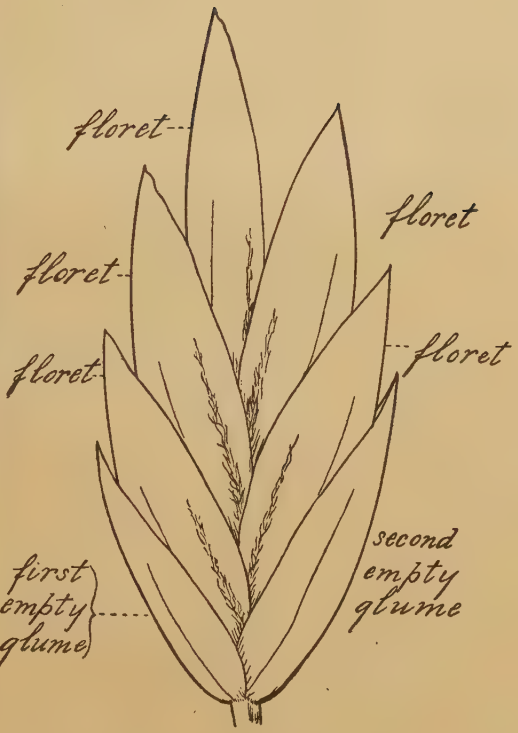

FIG. 51—A SPIKELET

Next is the palet, which is another leaf-like organ, usually having two ridges on the back, with a furrow between them, thus adapting it to fit snugly against the floret next above it in the spikelet. The empty glumes, the floral glumes, and the palets constitute the "chaff." In reading what follows it is well to refer frequently to Fig. 53, otherwise this description will be meaningless to those not familiar with the study of botany. The ovary is the part that afterward develops into the grain or seed. But no seed could be formed were it not for the anthers.

It will be seen in the figure that at the top of the ovary there are two large feather-like projections. These are the *styles*. Over a portion of the surface of the style the skin is missing, the bare flesh of the style being exposed to the air. This bare area is called the stigma. At a certain stage in the development of the flower the stigma is covered with a gummy substance which is of great importance in the economy of the flower.

Let us now turn to the anthers, of which the blue-grass flower has three. When ripe these anthers are filled with exceedingly small, round, yellowish bodies called pollen grains. About the time the gummy substance appears on the stigma the anthers burst and a shower of pollen falls. When one of the pollen grains strikes on the stigma it sticks there. (See *p*, Fig. 54). This gum seems to act as a sort of stimulus to the pollen grain, for the grain soon sends out a slender rootlet (pollen tube, *pt*. Fig. 54,) which grows down into the flesh of the stigma much the same as a root grows down into the soil. Now there is down in the ovary a

FIG. 52—A PANICLE

little body which is in many respects a counterpart of a pollen grain, and which is called an ovule (*e*, Fig. 54). The rootlet from the pollen grain continues to grow down through the substance of the stigma and the ovary until it finds the ovule. It seems to be guided in some unknown way to the very point where the ovule is found. As soon as the rootlet (pollen tube) touches the ovule, some small particles of living matter in the tube (*r*, Fig. 54,) pass through he wall of the tube and enter the ovule. What occurs then in the ovule would take many pages to tell. Suffice it to say that one of the living particles from the pollen tube unites with a very similar particle in the ovule, and the two then begin to grow and a seed is formed. The little particle in the ovule cannot grow unless it unites with the similar particle from the pollen tube. It is frequently the case that ears of corn on the west side of a field have grains missing. This is due to the fact that while the pollen was falling the wind blew most of it away, and some of the hairs of the silk (these hairs are the styles) had no pollen grains light on their stigmas.

In some grass flowers the styles protrude from the flowers before the anthers do. When in this stage a grass is popularly said to be in its first bloom. In those that protrude their anthers first, or at the same time with their styles, before the anthers burst they are said to be in their first bloom. Later, when the anthers have shed their pollen, and hang limp on their slender filaments, the plant is said to be in second bloom. Most of the coarser grasses make the best hay if cut in their second bloom—that is, when they are just going

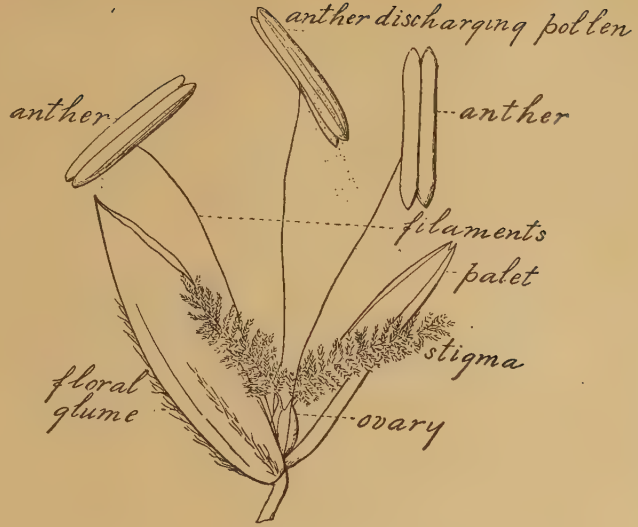

FIG. 53—PARTS OF A SINGLE FLORET

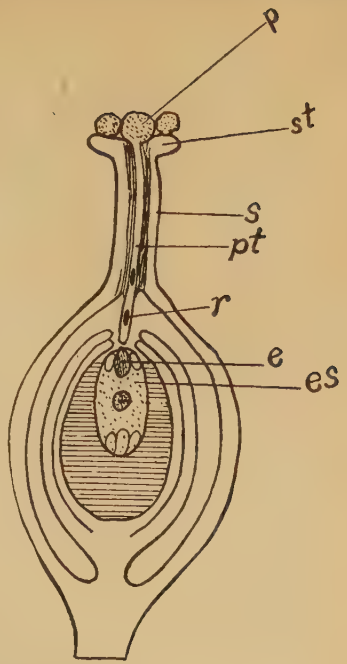

FIG. 54—SHOWING ACTION OF POLLEN

out of blossom. It is believed by many that if a grass is cut for hay when it is shedding its pollen that the hay is inferior in quality, because of the presence of the pollen dust. How much truth there is in this notion is not known. Recent investigations indicate that the pollen of some of the grasses, when breathed into the nostrils, causes hay-fever, a disease in which the mucus membrane of the nasal passages is much inflamed. It is possible that pollen dust in hay may cause some trouble in the nasal passages of horses and cattle.

After the pollen falls on the stigma, and sends its thread-like tube down through the substance of the style and the ovary to the ovule, the seed at once begins to develop. The time required for the development of the seed varies with different grasses from a few days to several weeks. In the common hay grasses it is about ten days or two weeks. At first the substance of the seed is watery in appearance. Just before it reaches its full size it becomes milky. At this time the seed is said to be "in the milk." If the hay is cut when the seed is in the milk, some of the seed usually matures sufficiently to grow. This is important in the case of weedy grasses, like Johnson grass and quack-grass. These should never be left till the milk stage is reached. When the milk-like substance of the seed begins to harden, the seed is popularly said to be "in the dough." Most seeds will grow readily if the whole plant is cut at this stage, though they will hardly mature properly if the seed is removed from the plant in the dough stage. Very few grasses make good hay if cut after the seed is fully mature.

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